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Pratt & Whitney Aircraft

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PWA FP 66-100
SEPTEMBER 1966

571 p.

(6) ENGINE PROPOSAL
FOR PHASE III OF THE
SUPERSONIC TRANSPORT DEVELOPMENT PROGRAM,

VOLUME V. MANAGEMENT AND MANUFACTURING

REPORT H - DETAIL WORK PLAN,

(15) FA-SS-66-8

(14) PWA-FP-66-100-Vol-5

(COMPETITIVE DATA)

PREPARED FOR
FEDERAL AVIATION AGENCY
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WASHINGTON, D. C.

Pratt & Whitney Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION
FLORIDA RESEARCH AND DEVELOPMENT CENTER

(401 355)

Printed in United States of America

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REPORT H
DETAIL WORK PLAN

INTRODUCTION

This report presents a description of the total effort to be accomplished in the design, development, prototype delivery and operational support of the Pratt & Whitney Aircraft JTF17 engine during Phase 3 ~~III~~ of the Supersonic Transport Engine Program. This total effort includes: ~~Section I~~ Engine and Component Development; ~~Section II~~ Management Controls and Product Assurance; and ~~Section III~~ Delivery and Product Support. The material ~~in this plan~~ is presented in relation to the Level 3 ~~III~~ areas of the work breakdown structure with each Level 3 ~~III~~ area providing an activity description, milestone chart and network chart, including an event dictionary for each network chart. For those areas where a network is inappropriate, only a schedule is presented. The Level 3 ~~III~~ areas of the work breakdown structure are described in the Work Statement in Volume 6 ~~VI~~. of this proposal.

This engine development program is patterned upon our previous development programs for both commercial and military engines. Specifically, the JTF17 engine development program follows the development steps of the high Mach number J58 engine, and reflects the beneficial and invaluable lessons learned from the integration of the engine and airframe through extensive flight and operational experience. The Pratt & Whitney Aircraft JTF17 engine development program also incorporates the added effort required to make the supersonic transport engine suitable for commercial service, and reflects the experience gained in over 39 million hours of turbojet engine operation in commercial service.

It is the goal of the JTF17 engine program to develop the engine to meet the requirements of the engine model specification and to obtain the engine maturity required for commercial use. Demonstration of this maturity will be the Flight Test Status Test required in Phase III, and the Certification Test required in Phase IV.

During Phase III a total of 20 engines will be delivered to the airframe manufacturer. Four engines will be delivered prior to FTS for ground test use. If required, four additional engines will be delivered for aircraft taxi tests. It is planned to modify the four taxi test engines after completion of the test to the FTS engine configuration for use in the prototype flight program. Sustaining engineering effort will be provided in Phase III to support the JTF17 prototype engine delivery and operation through the 100-hour aircraft flight program.

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SECTION I
ENGINE AND COMPONENT DEVELOPMENT

1.01 ENGINE DESIGN

Design of the JTF17 engine, excluding the prototype control system, will have been completed by the end of Phase II-C. Early in Phase III the design of the prototype control system will be completed, and engine manufacturing drawings and an assembly parts list will be prepared and released. Subsequent to the engine release, major effort will be devoted to continuous refinement of component designs based on changing airframe requirements and on test experience gained from component rig tests; from engine test stand operation; from our continuing high Mach number flight experience; and from our commercial engine operation. Refinements may consist of minor modifications or major redesigns, as requirements dictate. Alternative designs of engine components will be completed for evaluation; these designs will be based on results of the test program and continued analysis.

Major effort will continue to be devoted to considerations such as safety and reliability, performance, weight, maintainability, and value engineering. To secure the earliest possible testing experience, design information will be made available prior to completion of manufacturing drawings to allow advance procurement of raw materials and tooling for time-critical parts manufacture.

The design of component test rigs will be completed and manufacturing drawings released. The use of such rigs will supply data for the component and engine test program.

Close design coordination will be maintained with the airframe contractor. This coordination will be directed toward ensuring that installation requirements for both engine and airframe are realistic and are being met.

Full-scale design engineering mockups will be used and maintained to assist in the design and installation activities.

The major milestones, network chart and event dictionary for engine design are shown in figures 1 and 2, respectively.

A detailed description of Engine Design is presented in Volume III, Report B, and test integration of the design effort is presented in Test, Volume IV, Report E.

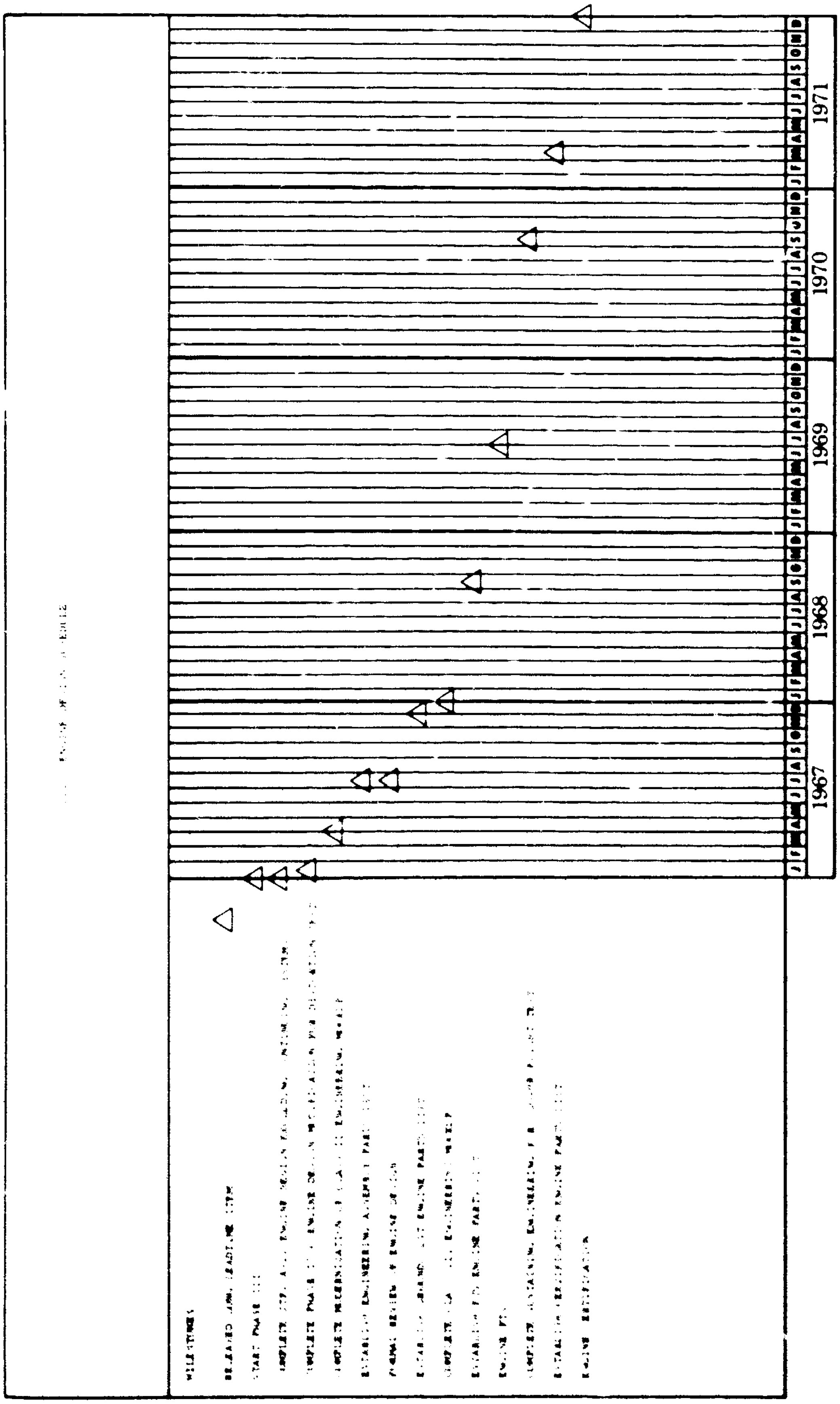

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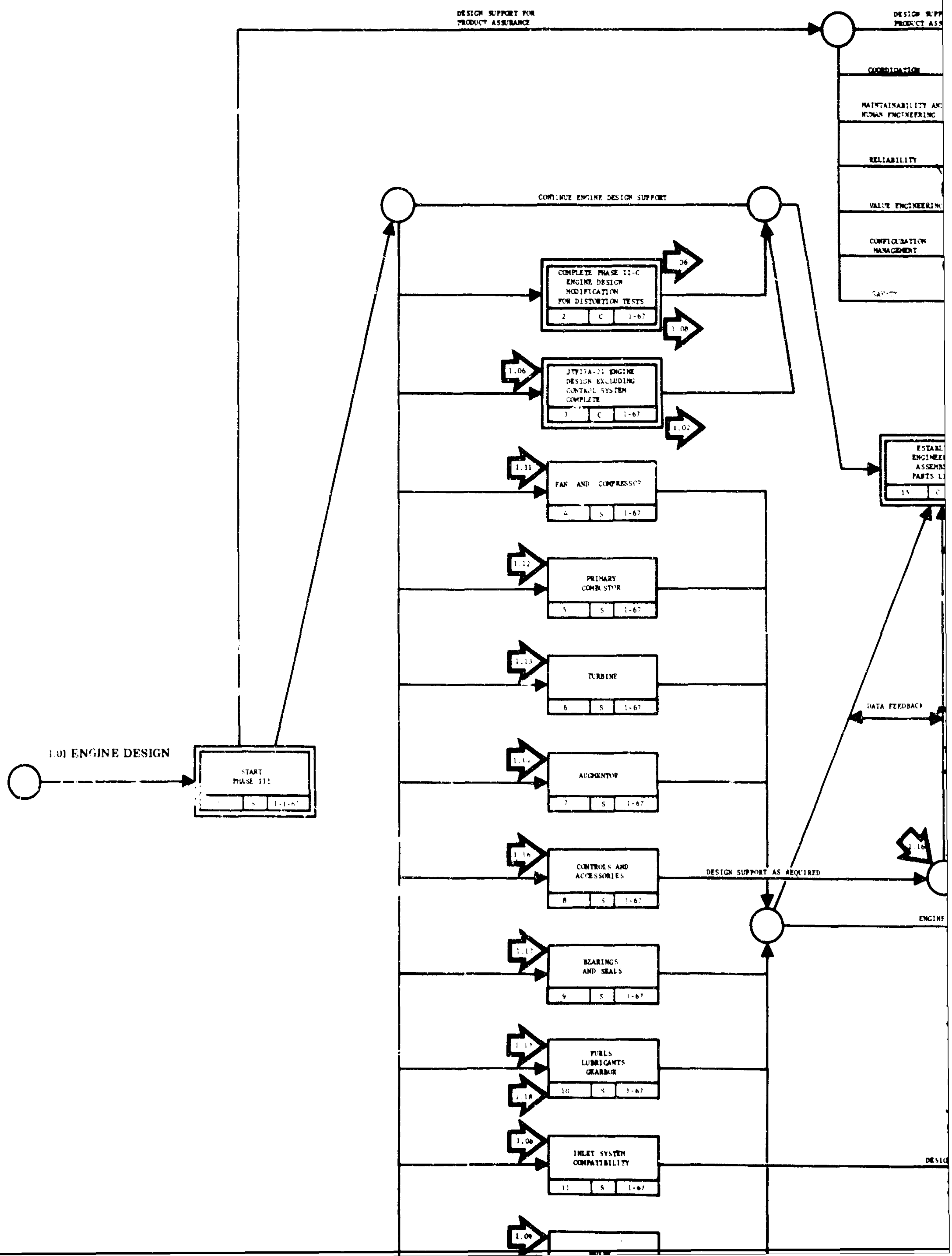
Figure 1. 1.01 Engine Design


1.01 ENGINE DESIGN
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RELIABILITY
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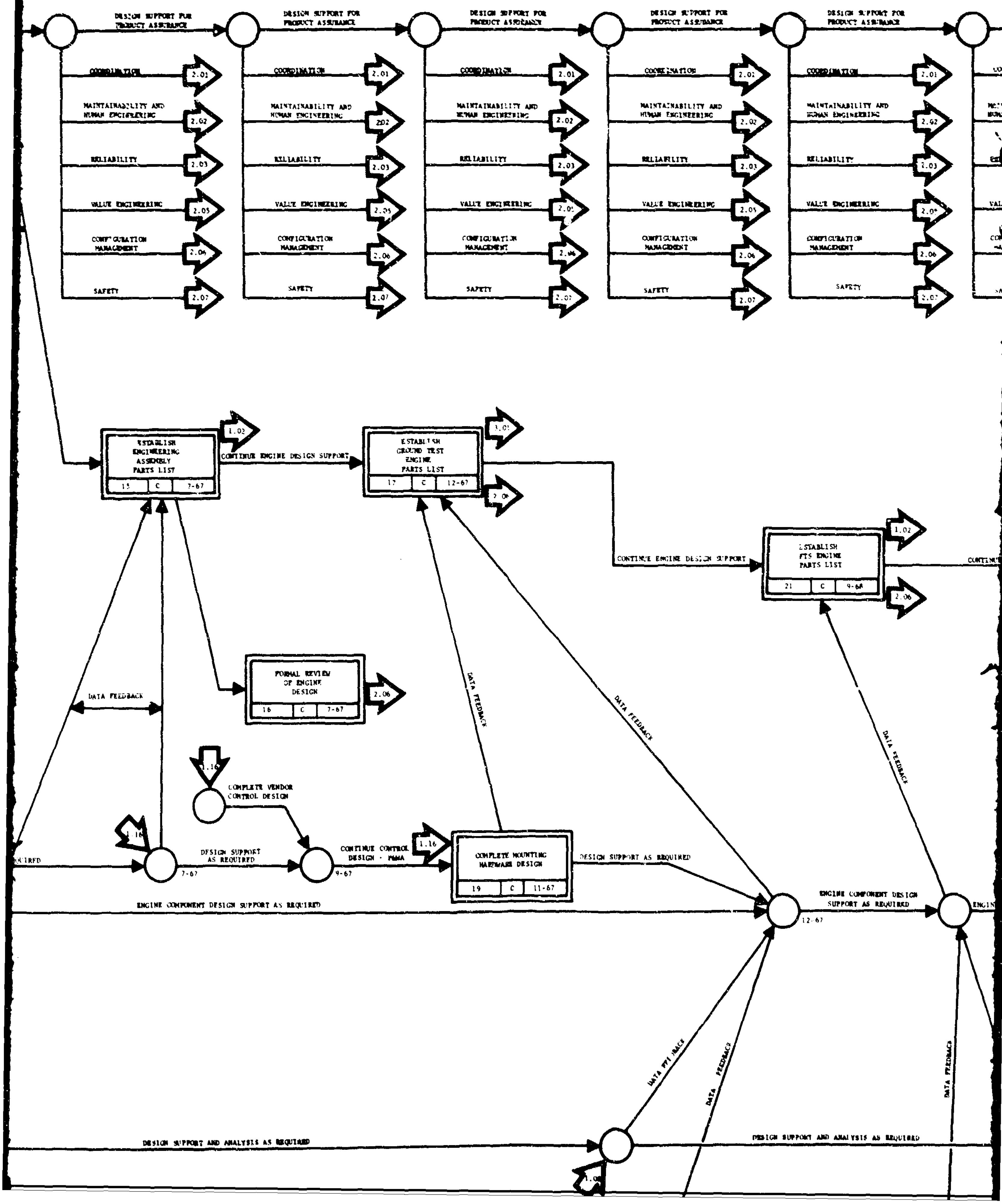
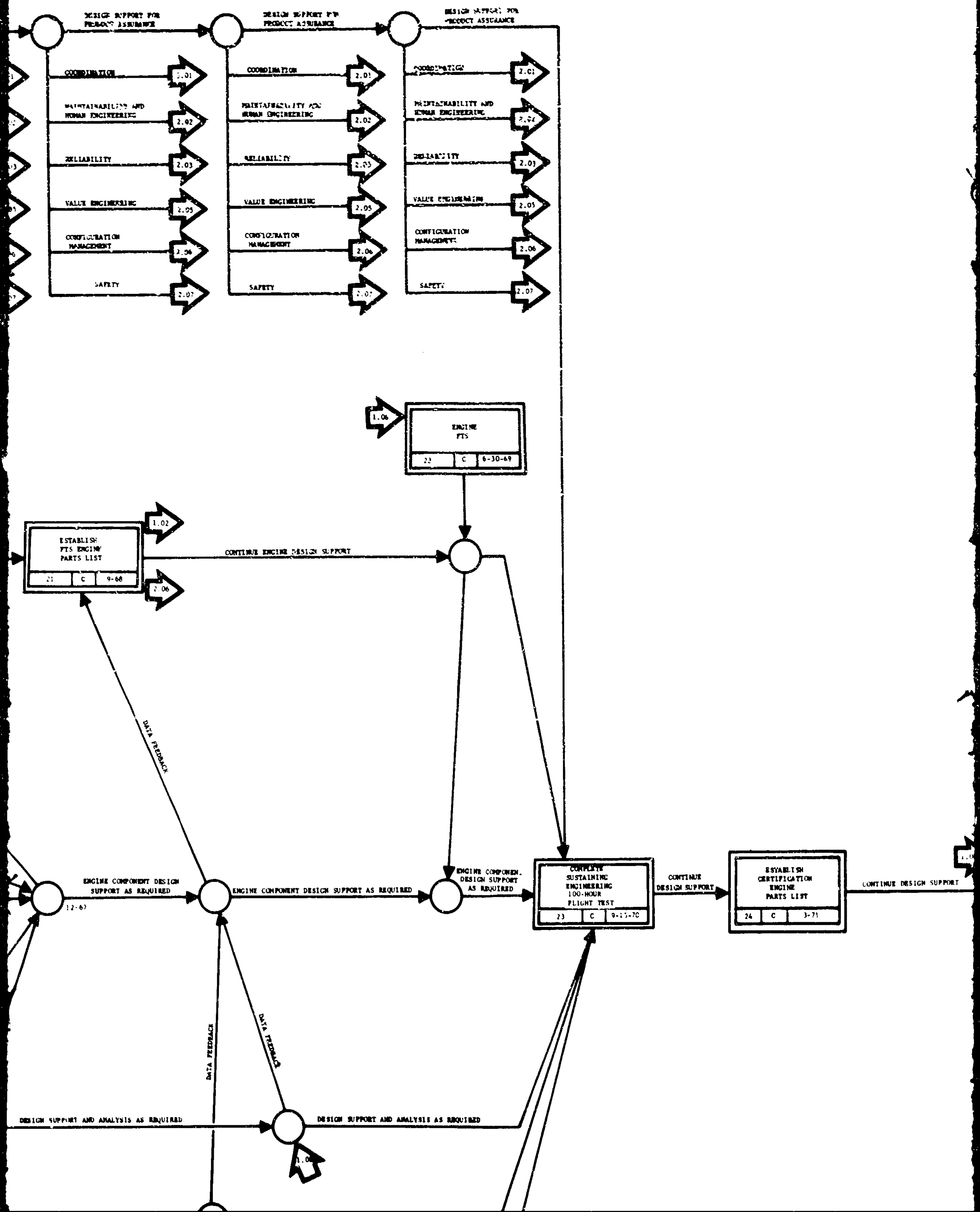
1.01 Engine Design




DESIGN SUPPORT FOR PRODUCT ASSURANCE
DESIGN SUPPORT FOR PRODUCT ASSURANCE
DESIGN SUPPORT FOR PRODUCT ASSURANCE
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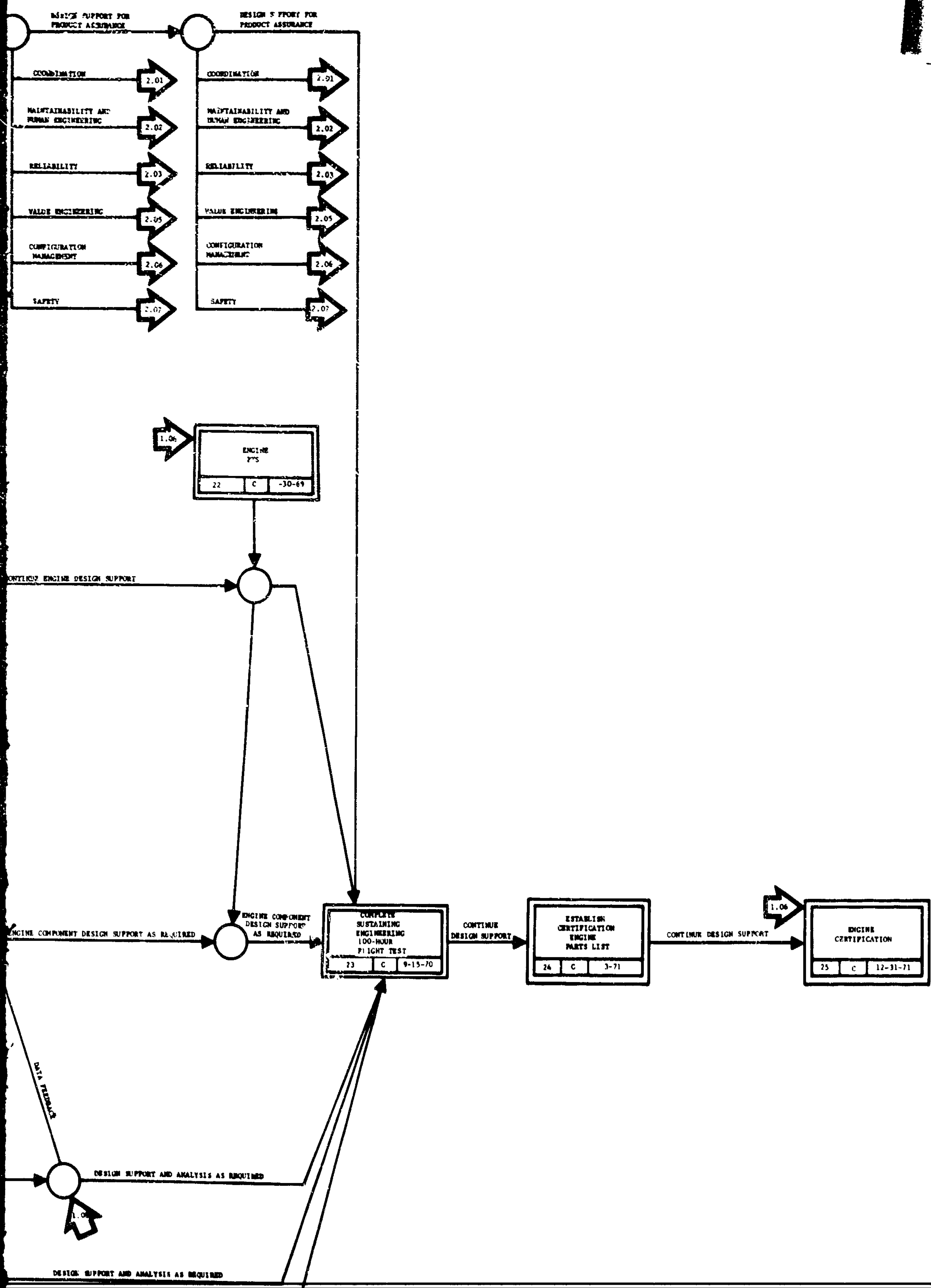
DESIGN SUPPORT AND ANALYSIS AS REQUIRED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12-31-71
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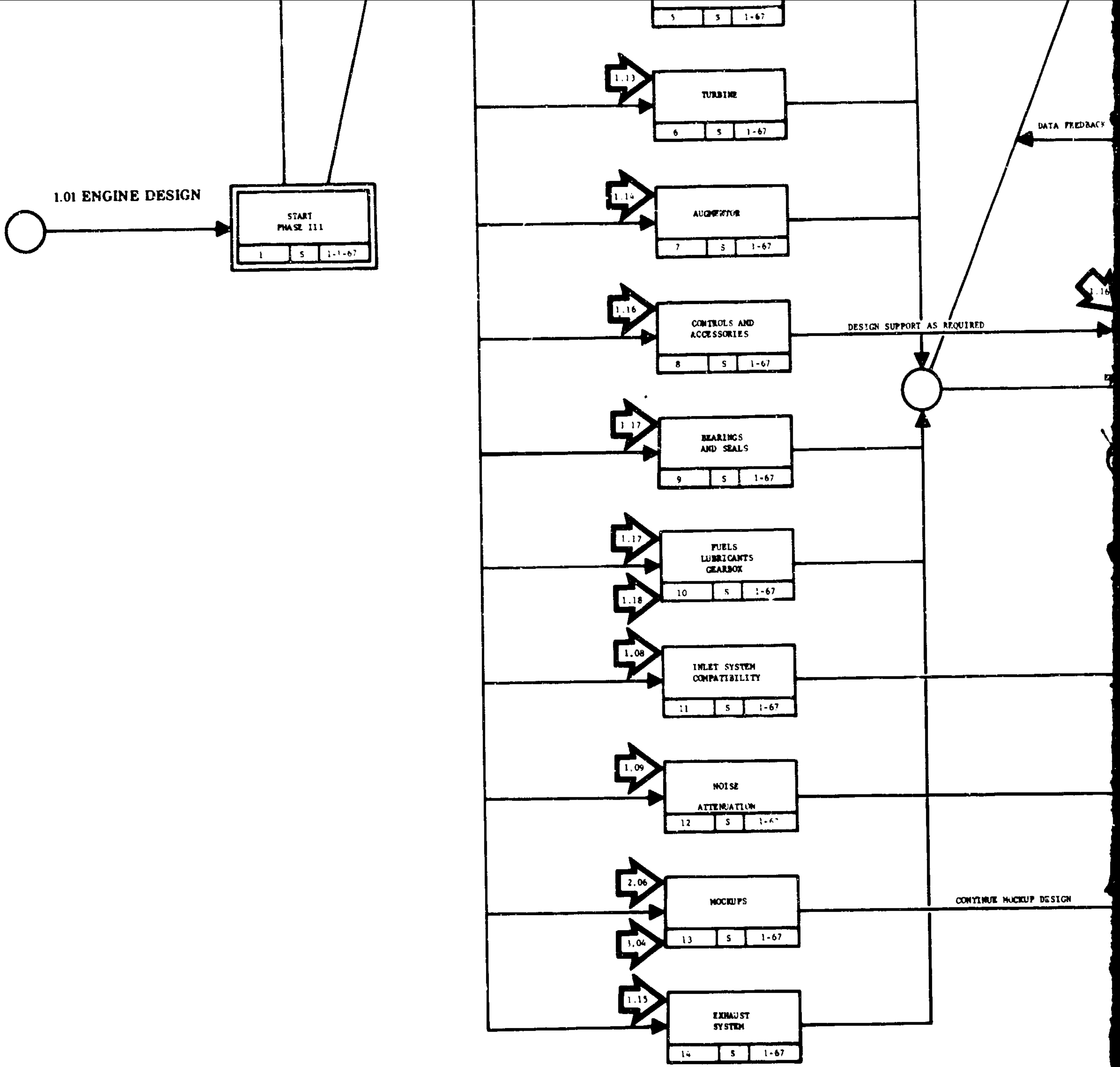
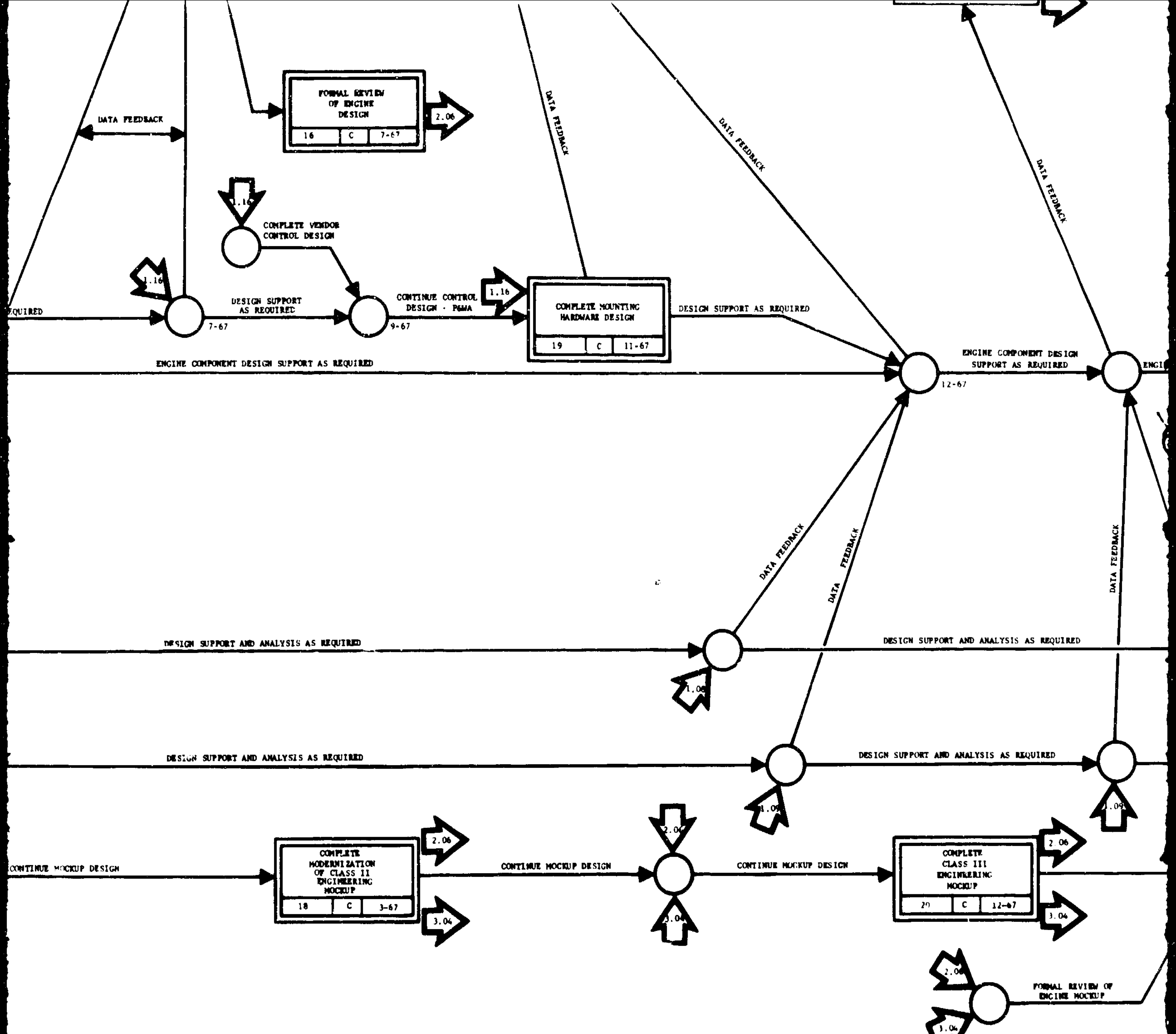
DESIGN SUPPORT AND ANALYSIS AS REQUIRED



Event Number	Description and Criteria	Event Number
1	START PHASE III Start of Phase III. Received Phase III go-ahead from FAA.	6
2	PHASE II-C ENGINE DESIGN MODIFICATIONS FOR DISTORTION TESTS Complete Phase II-C engine design modifications to investigate the effects of inlet distortion Release manufacturing drawings.	[illegible]
3	PROTOTYPE ENGINE DESIGN LESS CONTROLS SYSTEM Complete prototype engine design excluding controls system. Release of prototype engine manufacturing drawings.	8
4	FAN AND COMPRESSOR Continuing design effort to improve component performance, d rability and producibility. Phase III go-ahead.	9
5	PRIMARY COMBUSTOR Continuing design effort to improve component performance, durability and producibility. Phase III go-ahead.	10

Figure 2. 1.01 Engine Design



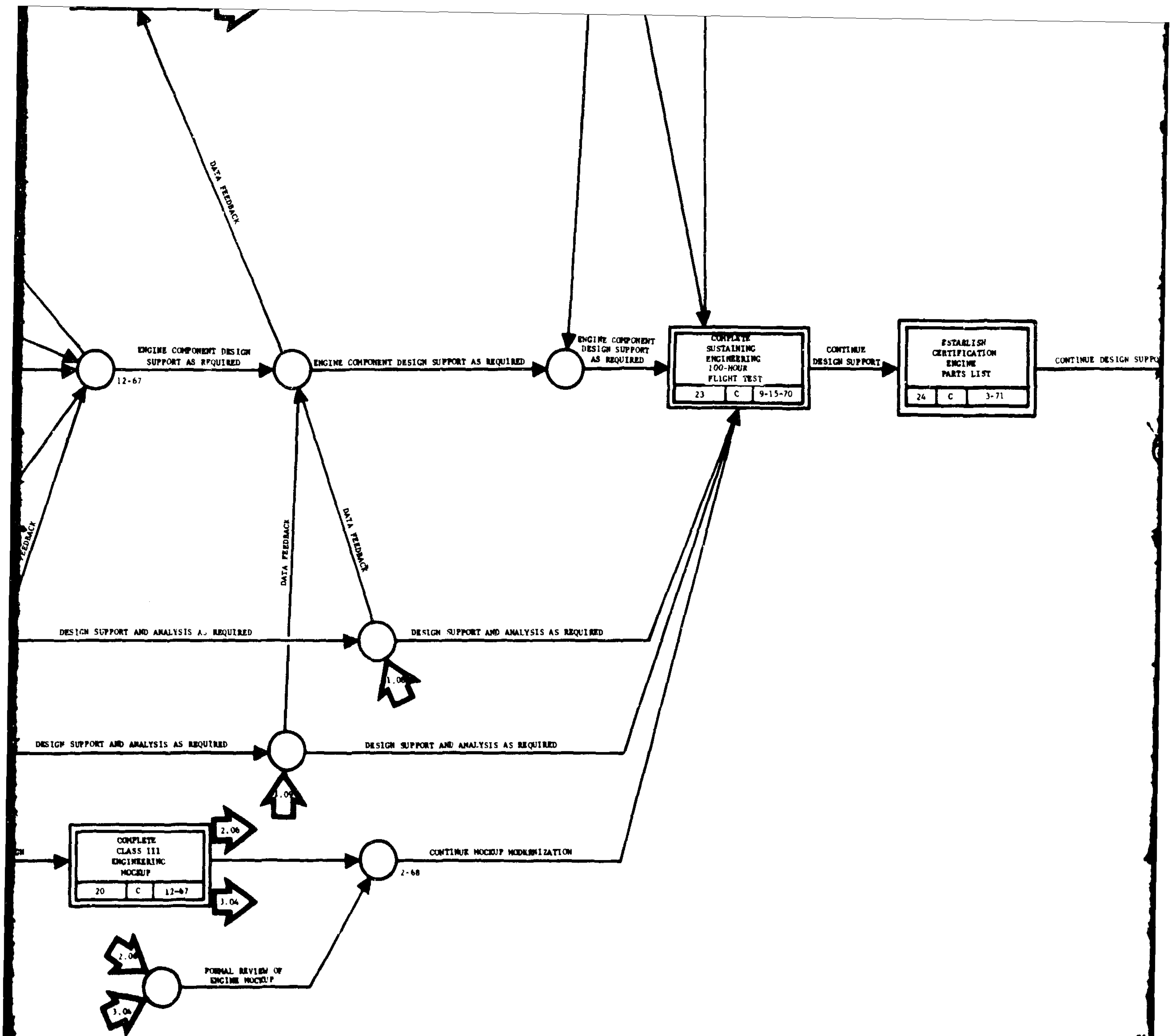
EVENT DICTIONARY
.01 ENGINE DESIGN

Event Number	Description and Criteria
6	**TURBINE** Continuing design effort to improve component performance, durability and producibility. Phase III go-ahead.
[illegible]	**AUGMENTOR** Continuing design effort to improve component performance, durability and producibility. Phase III go-ahead.
8	**CONTROLS AND ACCESSORIES** Continuing design effort to improve component performance, durability and producibility. Phase III go-ahead
9	**BEARINGS AND SEALS** Continuing design effort to improve component performance, durability and producibility. Phase III go-ahead.
10	**FUELS, LUBRICANTS AND GEARBOX** Continuing design effort to improve component performance, durability and producibility. Phase III go-ahead.

Event Number	Description and Criteria
11	**INLET SYSTEM COMPATIBILITY** Continuing design effort to improve component performance. Phase III go-ahead.
12	**NOISE ATTENUATION** Conti[illegible] design effort [illegible] improve noise attenuation. Phase III go-ahead.
13	**MOCKUPS** Continuing design effort to improve engine to airframe compatibility. Phase III go-ahead.
14	**EXHAUST SYSTEM** Continuing design effort to improve component performance, durability and producibility. Phase III go-ahead
15	**ENGINEERING ASSEMBLY PARTS LIST** Establish Engineering Assembly Parts List. Release of Parts List.

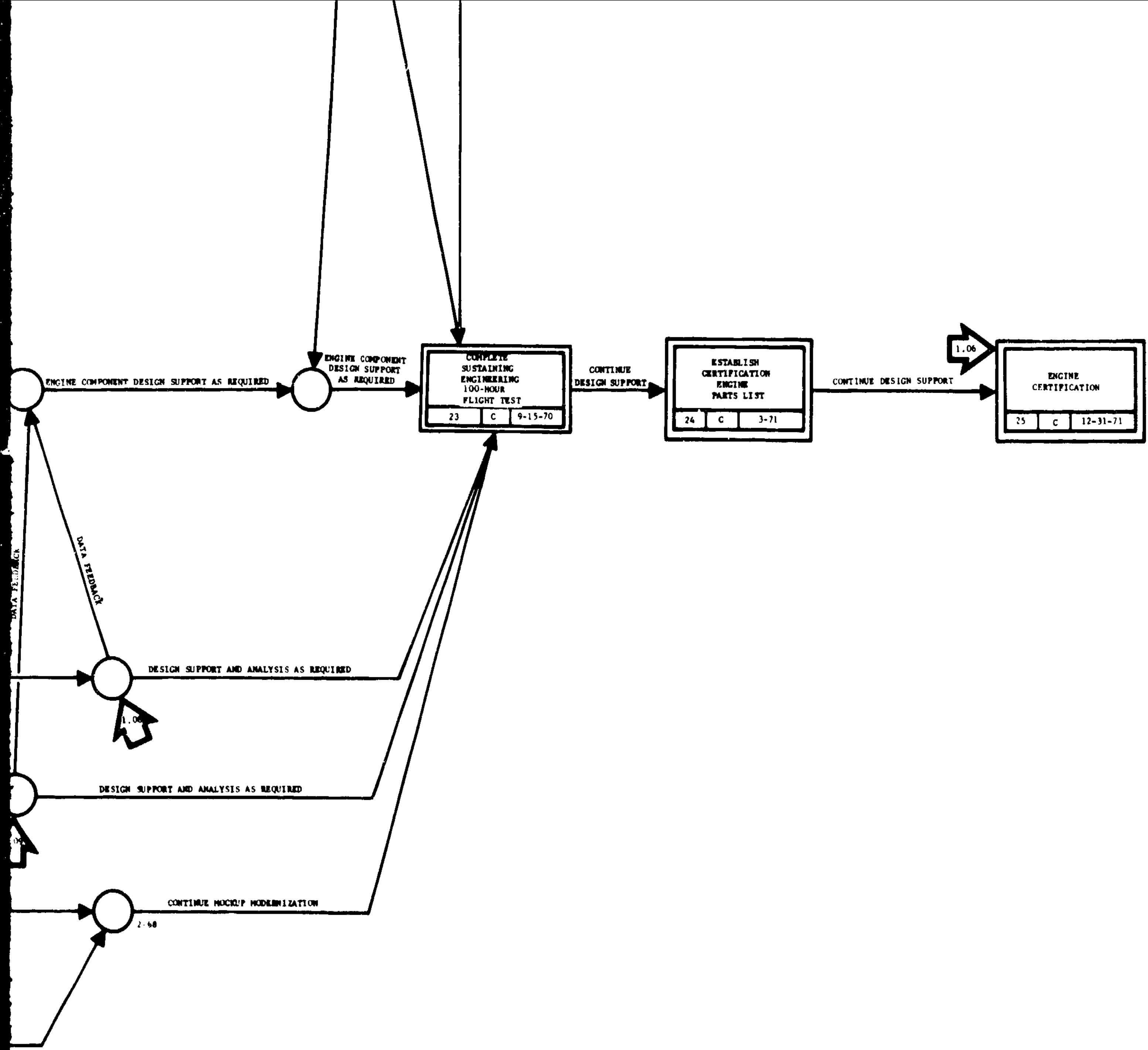
Event Number	Description an
16	**FORMAL REVIEW OF ENGINE** Conduct formal review Complete design review
1	**GROUND TEST ENGINE PARTS** Establish Ground Test en Release Parts List
18	**MODERNIZATION OF CLASS II** Complete modernization Engineering mockup is re
19	**COMPLETE MOUNTING HARDWA** Design of mounting hardw accessories is complete Release manufacturing dr
20	**COMPLETE CLASS III ENGIN** Complete fabrication an engineering mockup. E review

6



Event Number	Description and Criteria
16	**FORMAL REVIEW OF ENGINE DESIGN** Conduct formal review of engine design. Complete design review.
17	**GROUND TEST ENGINE PARTS LIST** Establish Ground Test engine Parts List. Release Parts List.
18	**MODERNIZATION OF CLASS II ENGINEERING MOCKUP** Complete modernization of engineering mockup Engineering mockup is ready for review
19	**COMPLETE MOUNTING HARDWARE DESIGN** Design of mounting hardware for controls and accessories is completed Release manufacturing drawings.
20	**COMPLETE CLASS III ENGINEERING MOCKUP** Complete fabrication and assembly of Class III engineering mockup. Engine mockup is ready for review

Event Number	Description and Criteria
21	**FTS ENGINE PARTS LIST** Establish FTS engine Parts List Release FTS engine Parts List
22	**ENGINE FTS** Reference engine network 1.06 for description and criteria
23	**COMPLETE SUSTAINING ENGINEERING FOR 100 HOURS FLIGHT TEST** End of Phase III Completion of 100-hour Flight Test Program
24	**CERTIFICATION ENGINE PARTS LIST** Certification engine manufacturing drawings are complete. Release of certification engine manufacturing drawings
25	**ENGINE CERTIFICATION** Reference engine network 1.06 for description and criteria



...iption and Criteria	Event Number	Description and Criteria
...P ENGINE DESIGN ... review of engine design. ...n review.	21	FTS ENGINE PARTS LIST Establish FTS engine Parts List Release FTS engine Parts List
...INE PARTS LIST ...d Test engine Parts List ...sat	22	ENGINE FTS Reference engine network 1.06 for description and criteria
...F CLASS II ENGINEERING MOCKUP ...ication of engineering mockup ...kup is ready for review	23	COMPLETE SUSTAINING ENGINEERING FOR 100 HOURS FLIGHT TEST End of Phase III Completion of 100-hour Flight Test Program
...ING HARDWARE DESIGN ...ing hardware for controls and ...mpleted ...ting Drawings	24	CERTIFICATION ENGINE PARTS LIST Certification engine manufacturing drawings are complete Release of certification engine manufacturing drawings
...III ENGINEERING MOCKUP ...ation and assembly of Class III ...kup ... mockup is ready for	25	ENGINE CERTIFICATION Reference engine network 1.06 for description and criteria

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1.02 FABRICATION AND ASSEMBLY

FABRICATION

JTF17 Project Engineering authorizes all development parts procurement by issuance of an Engineering Order Supplement, which defines the task to be accomplished and specifies the detail hardware requirements. This hardware is scheduled by quantity and date to predicted needs determined by Project Engineering. The total quantity of test support parts required over a period of one year can be expressed as equivalent sets of parts:

$$\frac{\text{Total Cost of all Test Support Hardware}}{\text{Average Cost of a Development Engine}} = \text{Number of Equivalent Sets of Parts}$$

The number of equivalent sets of parts and average number of engines predicted for the JTF17 development effort is as follows:

Year	1967	1968	1969	1970	1971
Average Number of Engines	4	7	11	12	14
Equivalent Engine Sets	11	12	12	12	12.5

Design layouts and detail drawings are approved by Project Engineering and are released from Design to Project Materials Control (PMC) for fabrication by an Experimental Release. Project Materials Control orders and schedules all parts, works directly through Purchasing for subcontracted hardware and works through Scheduling and Expediting for hardware made in-house.

Hardware fabricated "in-house" is submitted to Scheduling and Expediting and a job order is released to the Shop for manufacture. PMC writes Requests for Purchase Orders (RPO) for hardware designated "buy," the order is competitively quoted by Purchasing and placed. In either case, the promised completion or delivery dates must agree with the requested dates specified by Project Engineering. The PMC organization incorporates design changes rapidly. Design changes are discussed prior to release by Project Engineering and the PMC engineer, and "hold" instructions are issued if necessary until formal drawings are available. Hardware obsolescence is thus held to a minimum.

Raw material, when received, is inspected by the Materials Control Laboratory for compliance to specifications and by Quality Assurance for dimensional requirements. Finished purchased parts are inspected for compliance to the drawings and, where applicable, are submitted to the Materials Control Laboratory for testing. By arrangement with Quality Assurance, finished parts may be inspected at a subcontractor's plant.

ASSEMBLY

Assembly of the JTF17 development engines is controlled by an Experimental Engineer assigned to an engine build several months before the required starting date. The Experimental Engineer is responsible for defining the general configuration for the engine to Project Materials Control; PMC then issues a parts list to authorize delivery of the parts from Finished Stores. Engine rebuilds are handled in a similar manner, but a complete definition of parts is not established until inspection after disassembly.

New parts issued by Project Materials Control at the direction of Project Engineering, are delivered to Assembly for an engine or rig. Records of the parts issued are maintained with the engine or rig, and work done is by written instructions of the assigned Experimental Engineer. The rework or reoperation of parts is accomplished from Work Orders written by Assembly personnel. Parts shortage records are also maintained by Assembly personnel. The Shift Superintendent of Assembly conducts daily shortage meetings and scheduled build meetings to control engine and rig build schedules. During the build of the engine or rig, problems encountered are recorded on Deviation Reports which are used as a means of conveying design or deviate part problems to Engineering, Quality Assurance and PMC. Assembly Problem Reports are written to point out corrective action necessary on faulty assembly, damaged parts, or any abnormal conditions.

Engines and rigs returning from Test are disassembled in accordance with the written instructions of the Experimental Engineer.

In addition to engine and rig build service, the Assembly Department provides and installs all special pressure and temperature instrumentation. It also provides a test repair crew for engine and rig repair in the Test Areas and a small machine shop to expedite simple machining needs and special tool repairs.

Shop supplies, assembly tooling and special tooling used to support Engineering requirements are maintained by Assembly. In addition, the Assembly department provides a complete and current blueprint file for use by Assembly and Engineering personnel.

Special instructions to cover processes and materials as directed by Engineering Instructions or bulletins are issued by the Superintendent of Assembly. These are called Experimental Assembly Instructions (EAI). Experimental Assembly Operating Procedures covering methods of operation affecting tooling, parts handling, and agreed-to methods of operation are issued from the Assembly Office.

Special equipment such as flow benches, balance machines, spin testing, cleaning equipment, hoists and lifts, work benches and parts tables, etc., are provided and maintained to process engines and rigs through the assembly and disassembly cycles. These items of equipment also provide fulfillment for the manufacturing-in-process parts requirements such as balancing, pressure test, spin zyglo, and proof spinning.

The major milestones, network chart and event dictionary for fabrication and engine assembly are shown in figures 3 and 4, respectively.

A detailed description of fabrication and engine assembly is presented in the Test and Certification Plan, Volume III, Report E, and the Manufacturing Program, Volume V, Report G. Test planning and integration of fabrication and assembly is presented in Test, Volume IV, Report E.

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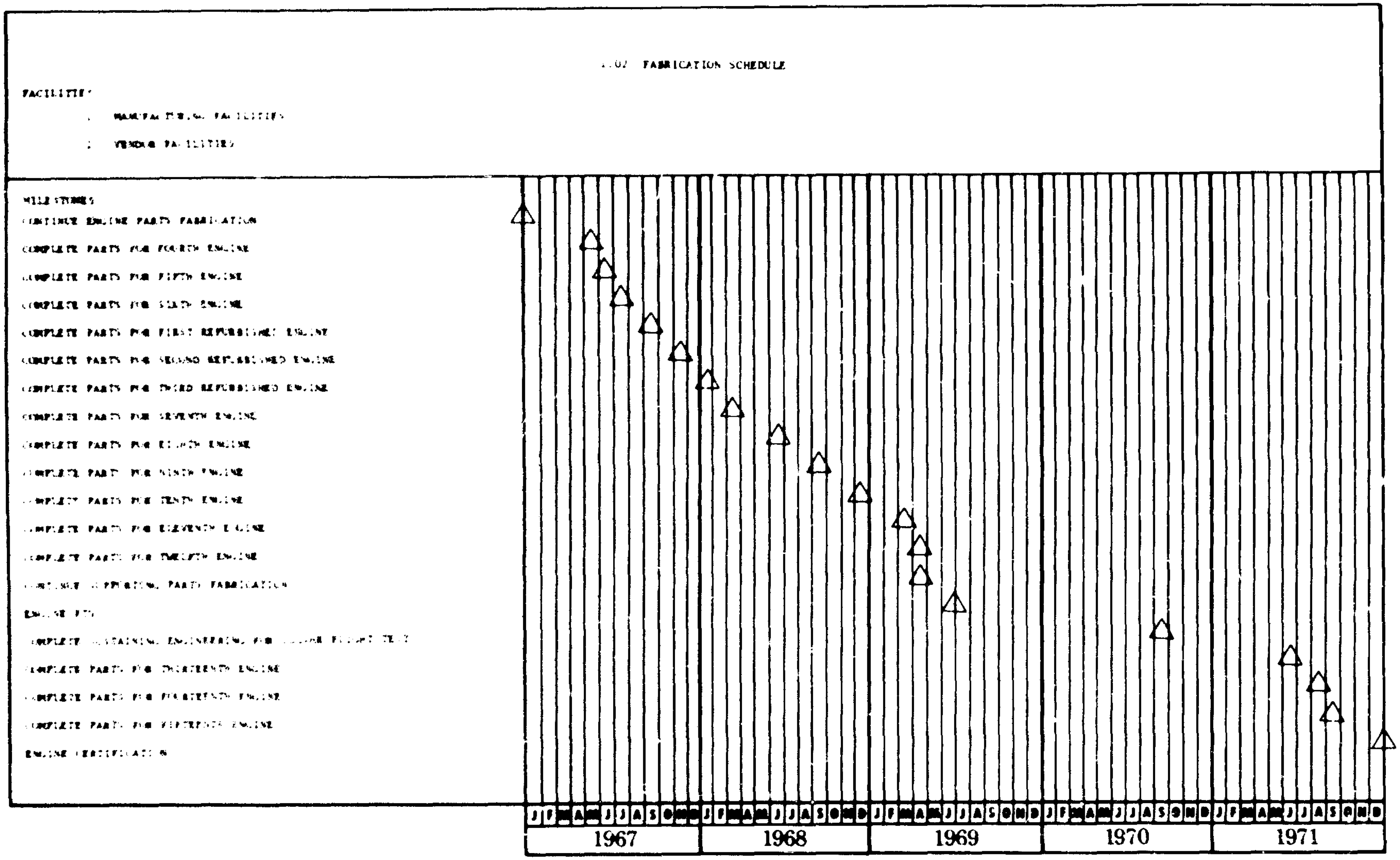

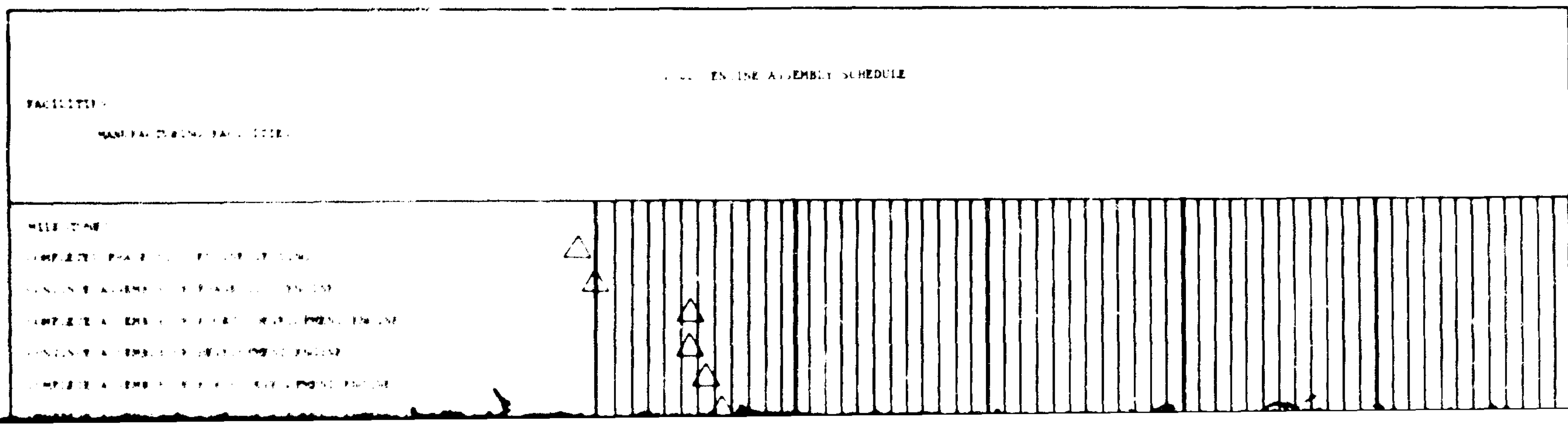

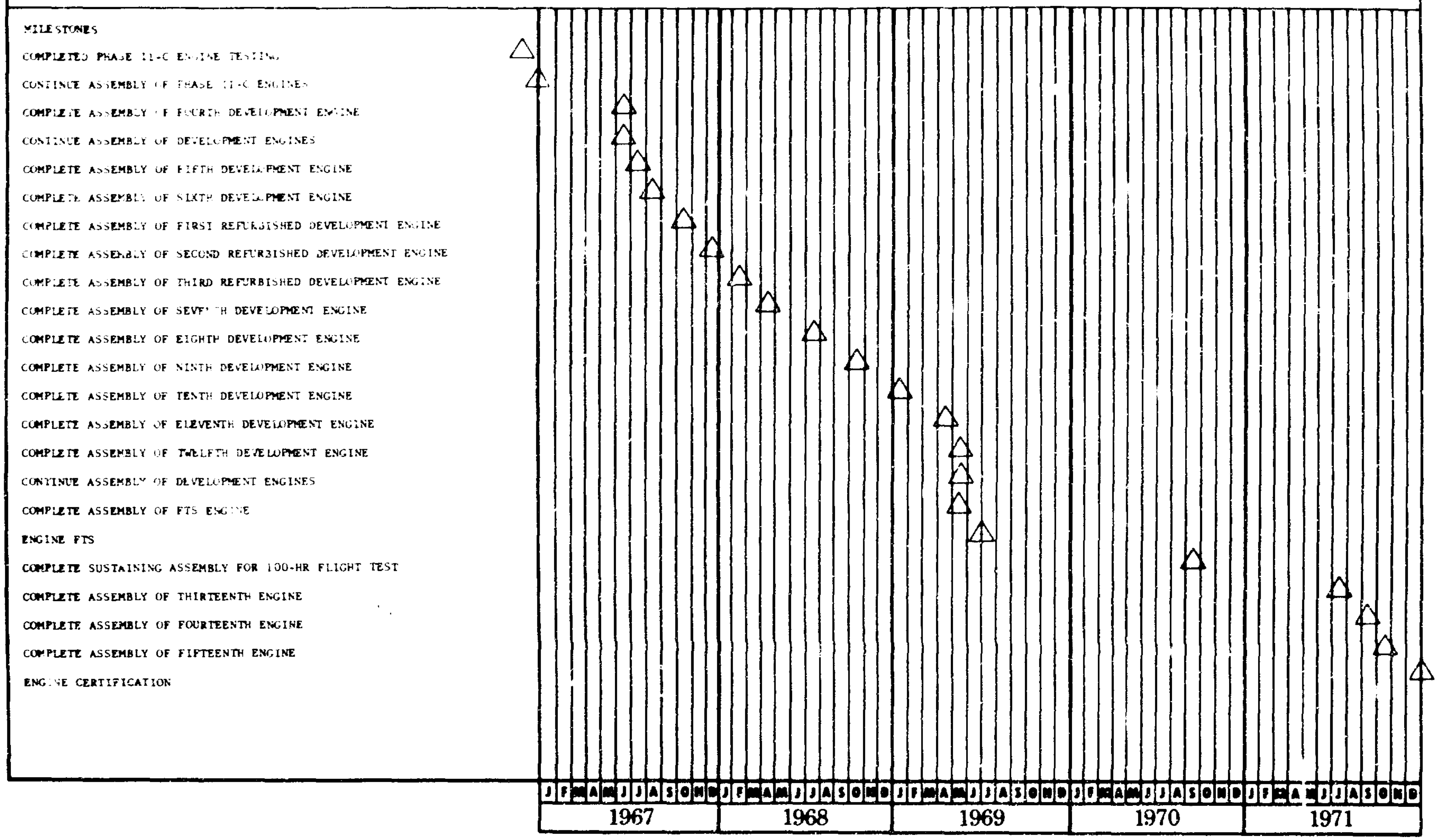

Figure 3. 1.02 Fabrication and Assembly

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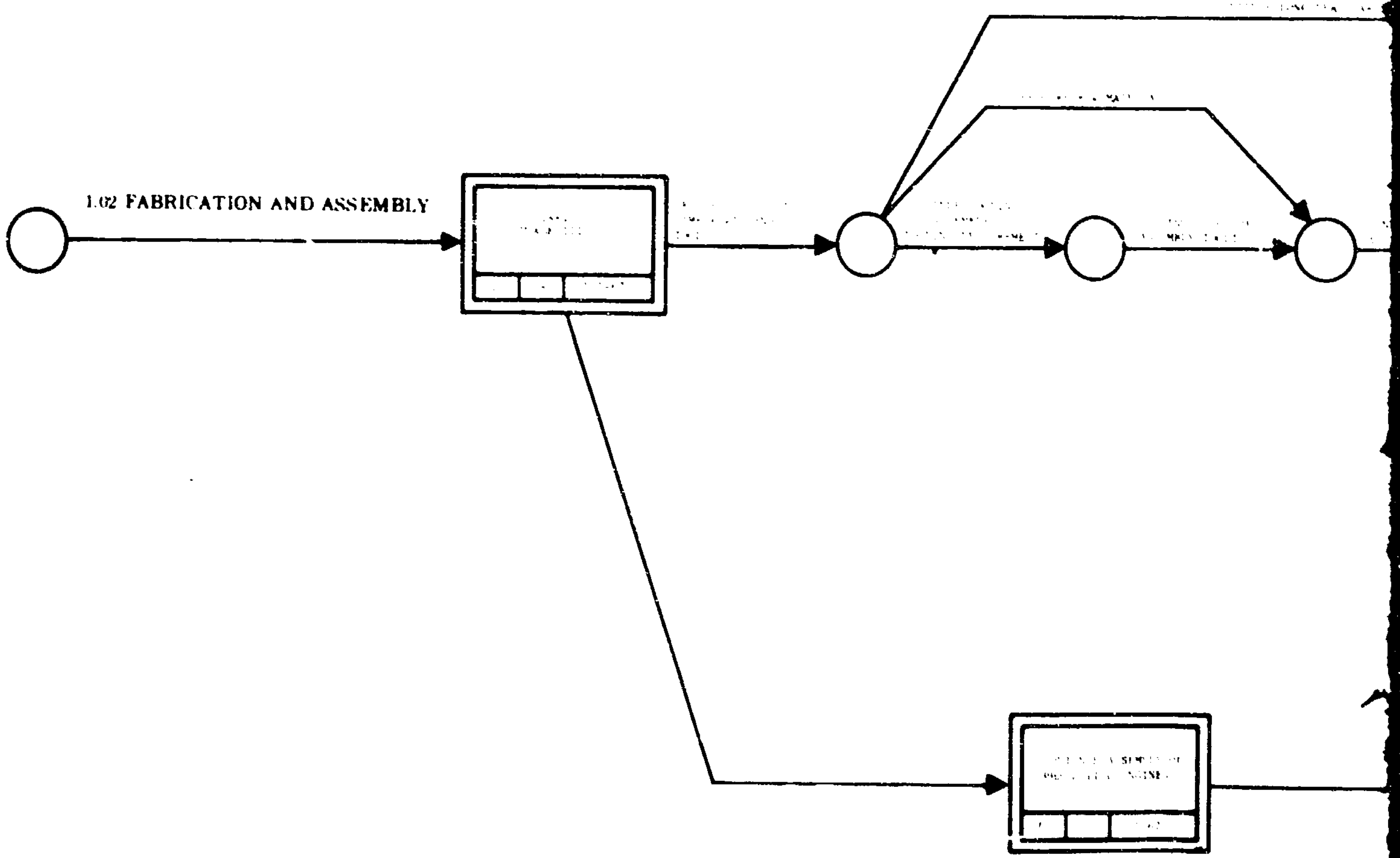
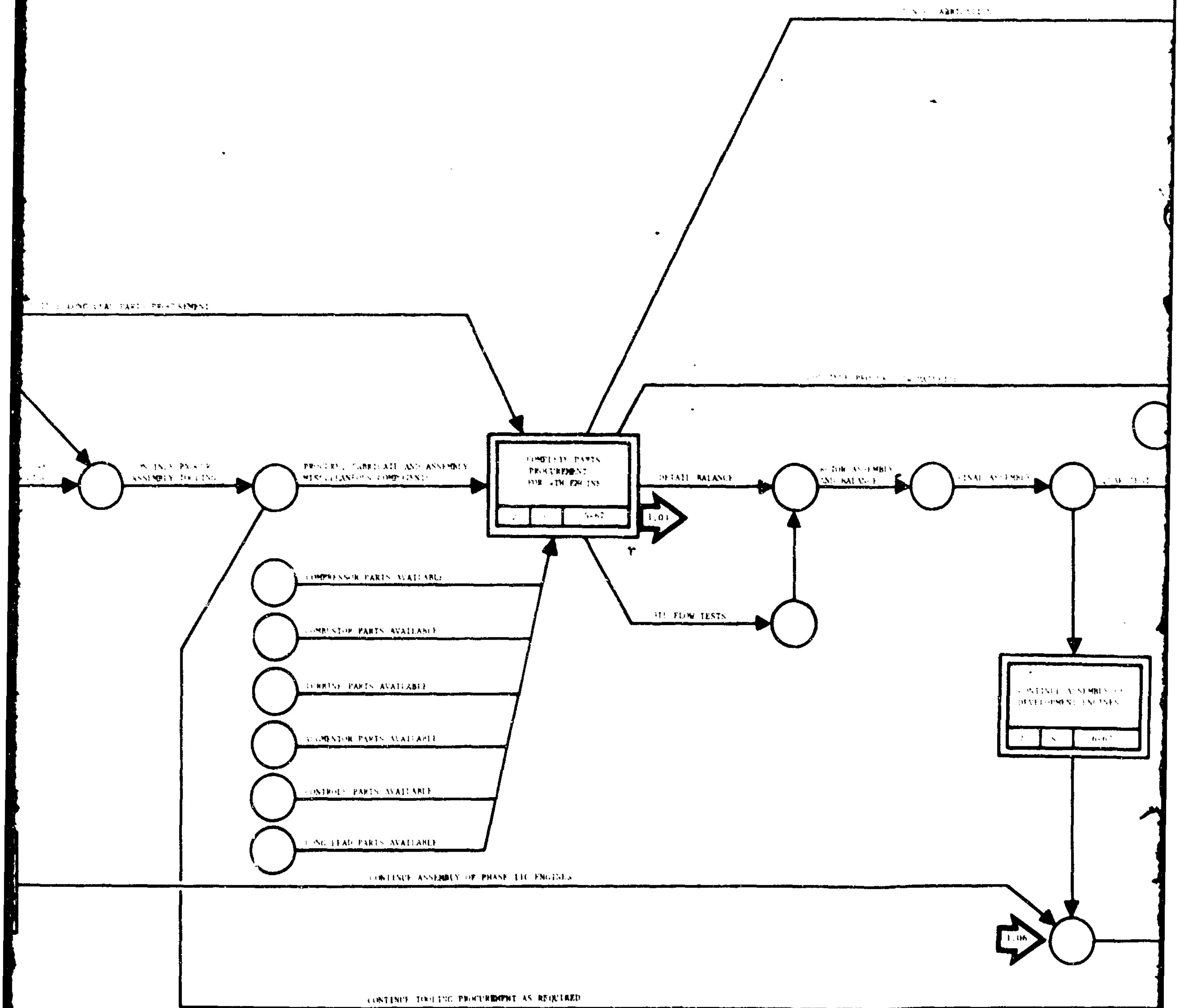


1.02 FABRICATION AND ASSEMBLY


PROCURE, FABRICATE AND ASSEMBLY MISCELLANEOUS COMPONENTS
DETAIL BALANCE
FLOW TESTS
FINAL ASSEMBLY
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COMPRESSOR PARTS AVAILABLE
COMBUSTOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
AUGMENTOR PARTS AVAILABLE
CONTROLS PARTS AVAILABLE
LONG LEAD PARTS AVAILABLE
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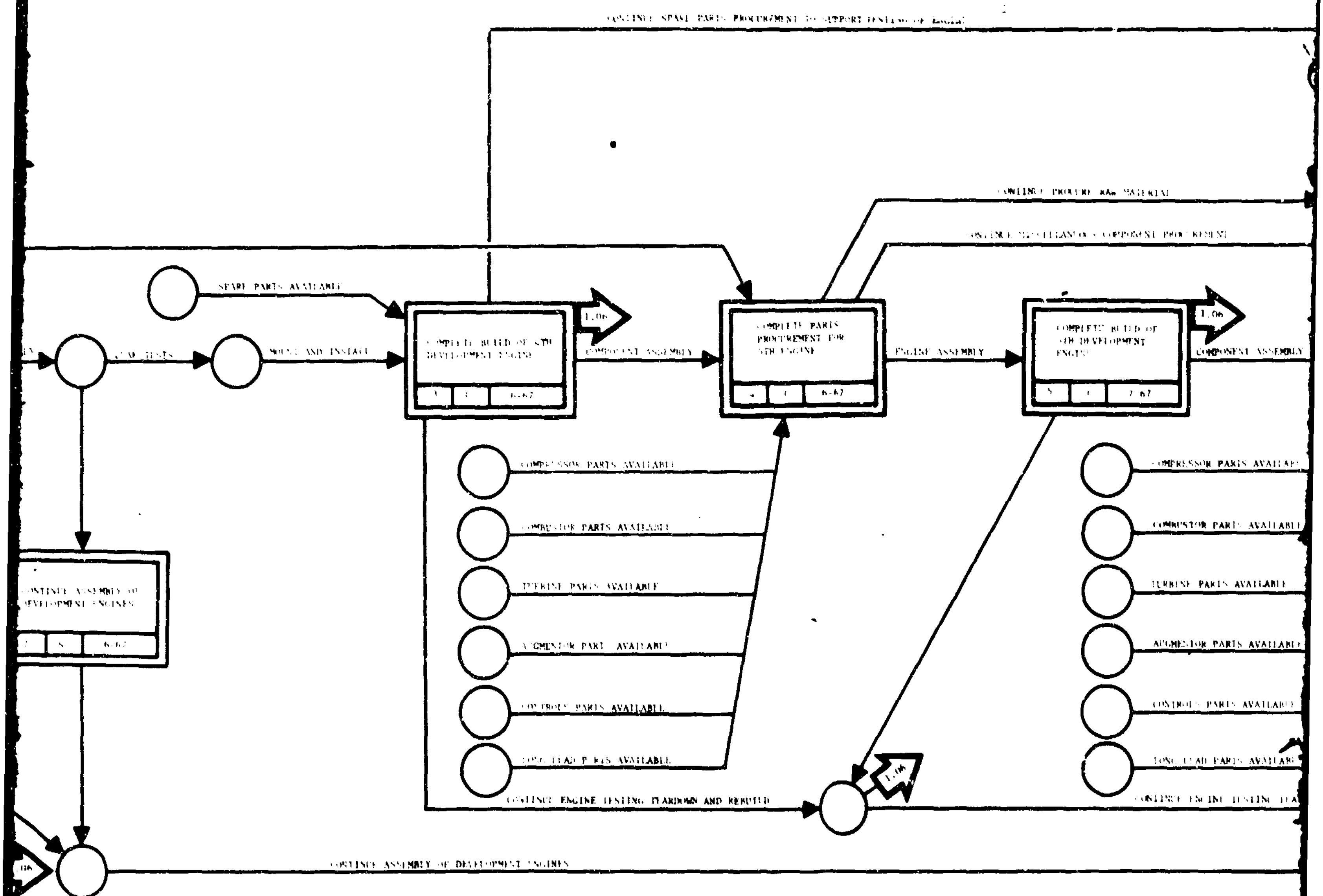
1.06
CONTINUE ASSEMBLY OF PHASE IIC ENGINES
CONTINUE TOOLING PROCUREMENT AS REQUIRED


CONTINUE SPARE PARTS PROCUREMENT TO SUPPORT TESTING OF ENGINE
CONTINUE PROCURE RAW MATERIAL
CONTINUE MISCELLANEOUS COMPONENT PROCUREMENT
SPARE PARTS AVAILABLE
MOUNT AND INSTALL
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COMPONENT ASSEMBLY
COMPLETE PARTS PROCUREMENT FOR
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ENGINE ASSEMBLY
COMPLETE BUILD OF
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COMPONENT ASSEMBLY
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COMBUSTOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
AUGMENTOR PARTS AVAILABLE
CONTROLS PARTS AVAILABLE
LONG LEAD PARTS AVAILABLE
CONTINUE ASSEMBLY OF DEVELOPMENT ENGINES
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CONTINUE ENGINE TESTING, TEARDOWN AND REBUILD
1.06
CONTINUE ASSEMBLY OF DEVELOPMENT ENGINES

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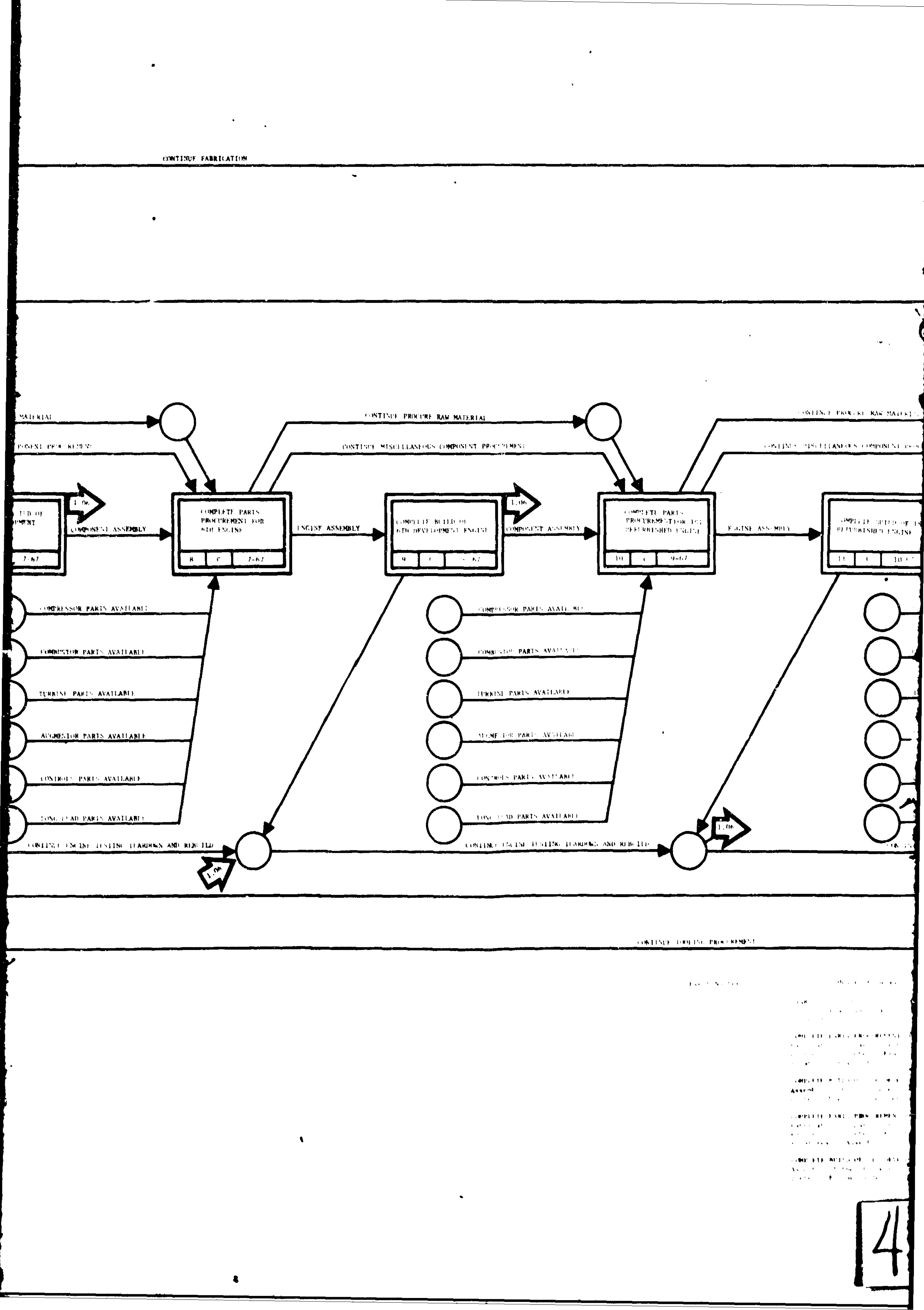
CONTINUE FABRICATION
CONTINUE PROCURE RAW MATERIAL
CONTINUE MISCELLANEOUS COMPONENT PROCUREMENT
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COMPONENT ASSEMBLY
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COMPLETE PARTS PROCUREMENT FOR 6TH ENGINE
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ENGINE ASSEMBLY
COMPLETE BUILD OF 6TH DEVELOPMENT ENGINE
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1.06
COMPONENT ASSEMBLY
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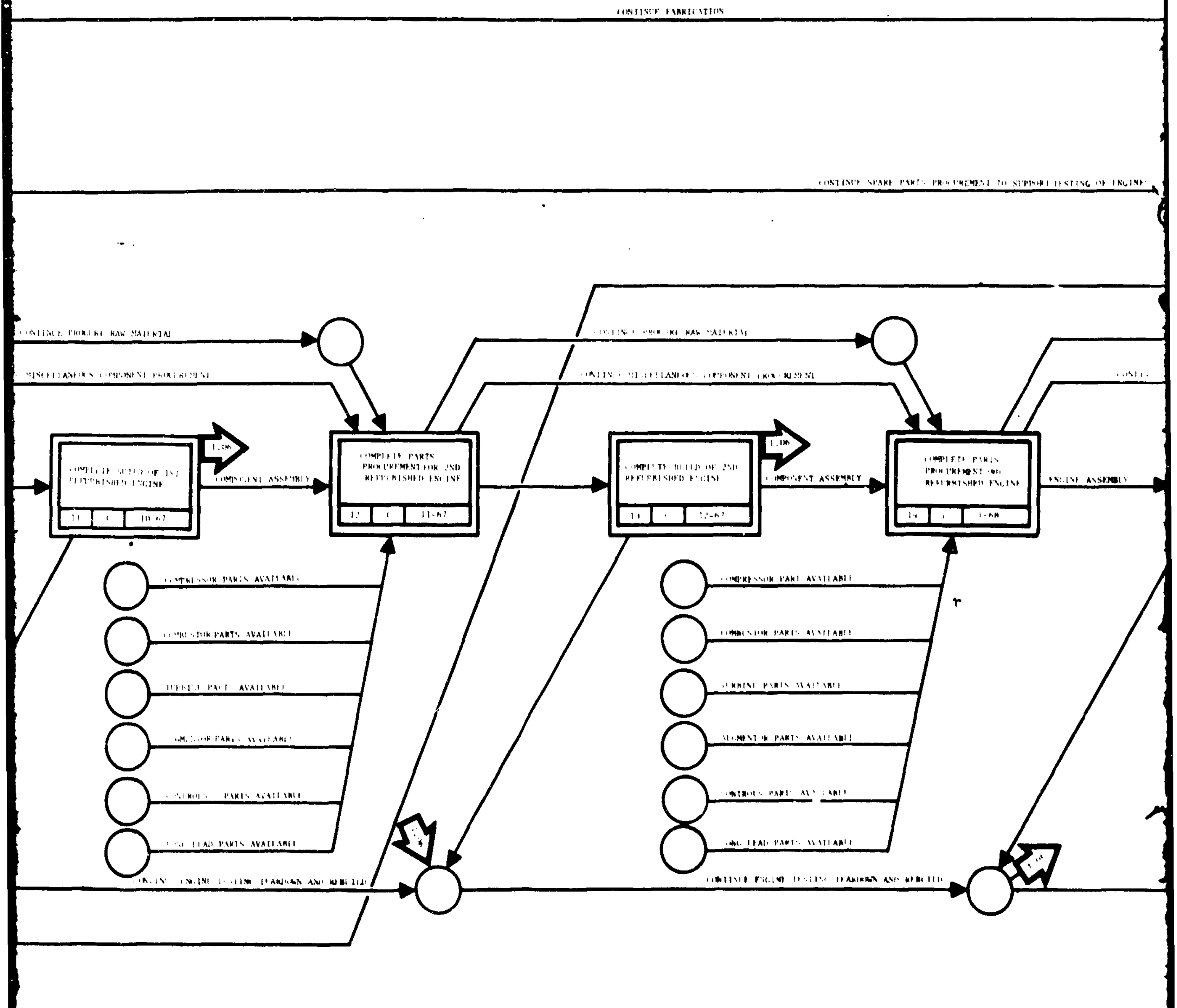
REFURBISHED ENGINE
COMPRESSOR PARTS AVAILABLE
COMBUSTOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
AUGMENTOR PARTS AVAILABLE
CONTROLS PARTS AVAILABLE
LONG LEAD PARTS AVAILABLE
CONTINUE ENGINE TESTING TEARDOWN AND REBUILD
CONTINUE TOOLING PROCUREMENT
4


CONTINUE FABRICATION
CONTINUE SPARE PARTS PROCUREMENT TO SUPPORT TESTING OF ENGINES
COMPONENT ASSEMBLY
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COMPLETE BUILD OF 2ND REFURBISHED ENGINE
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COMBUSTOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
AUGMENTOR PARTS AVAILABLE
LONG LEAD PARTS AVAILABLE
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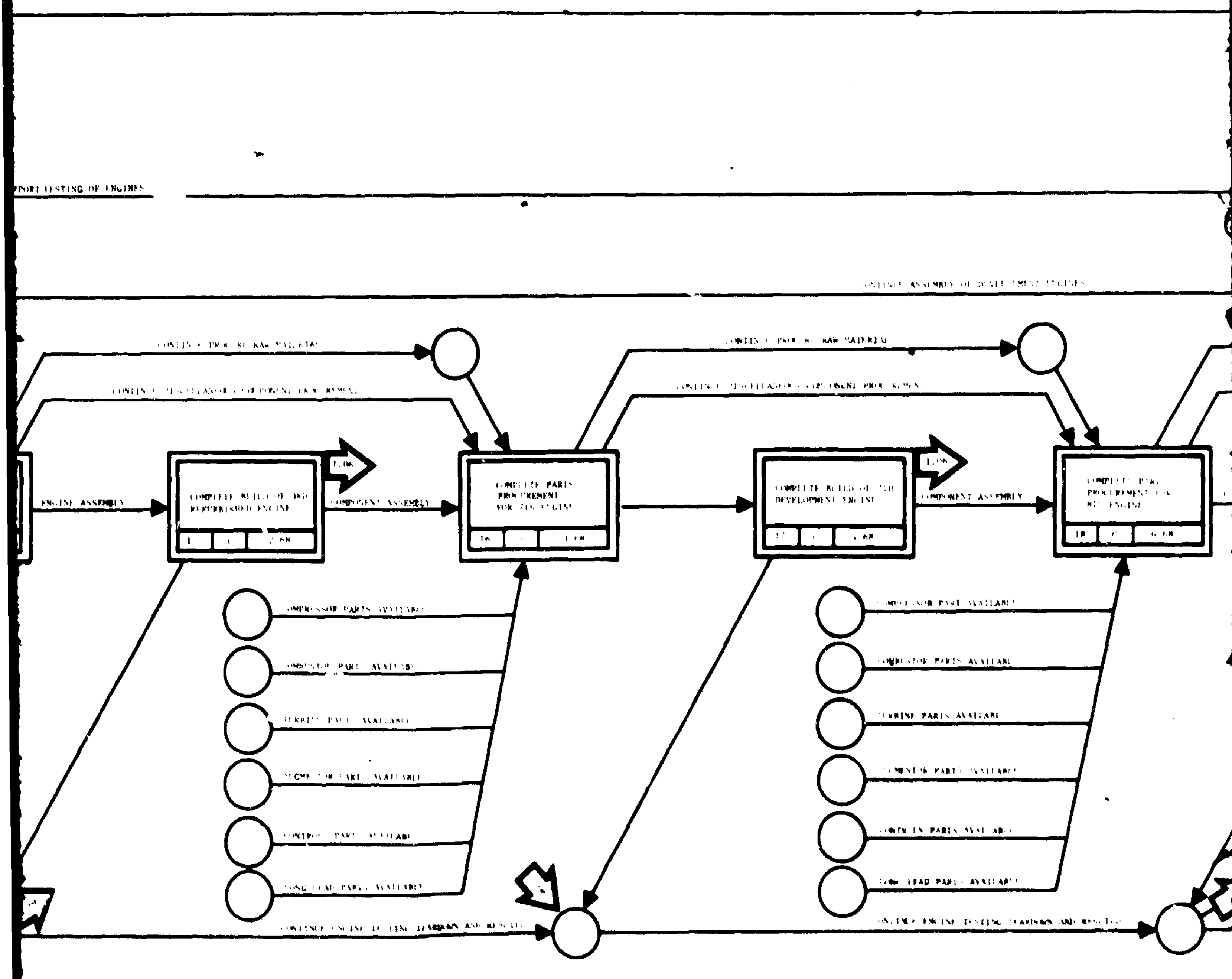
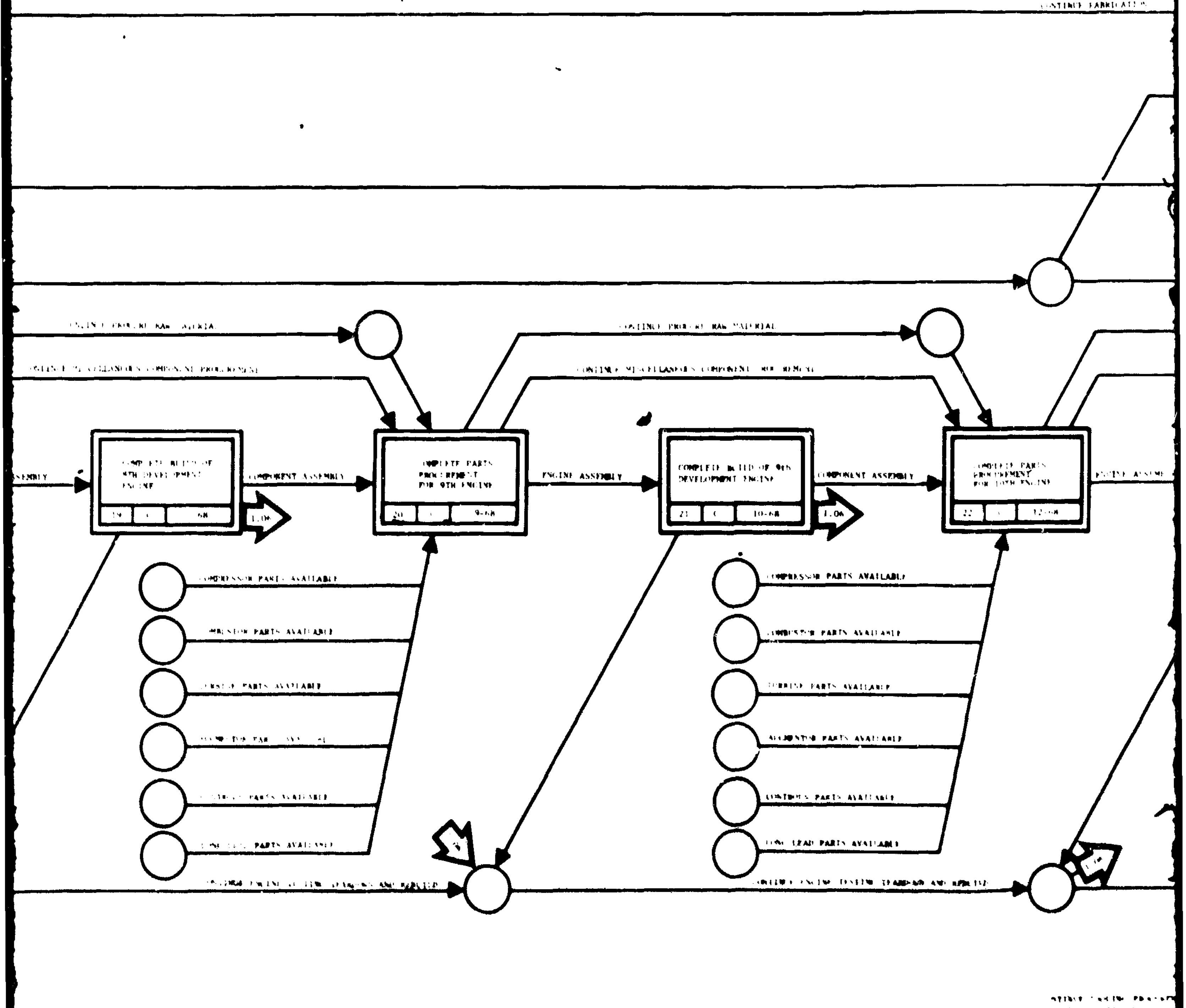
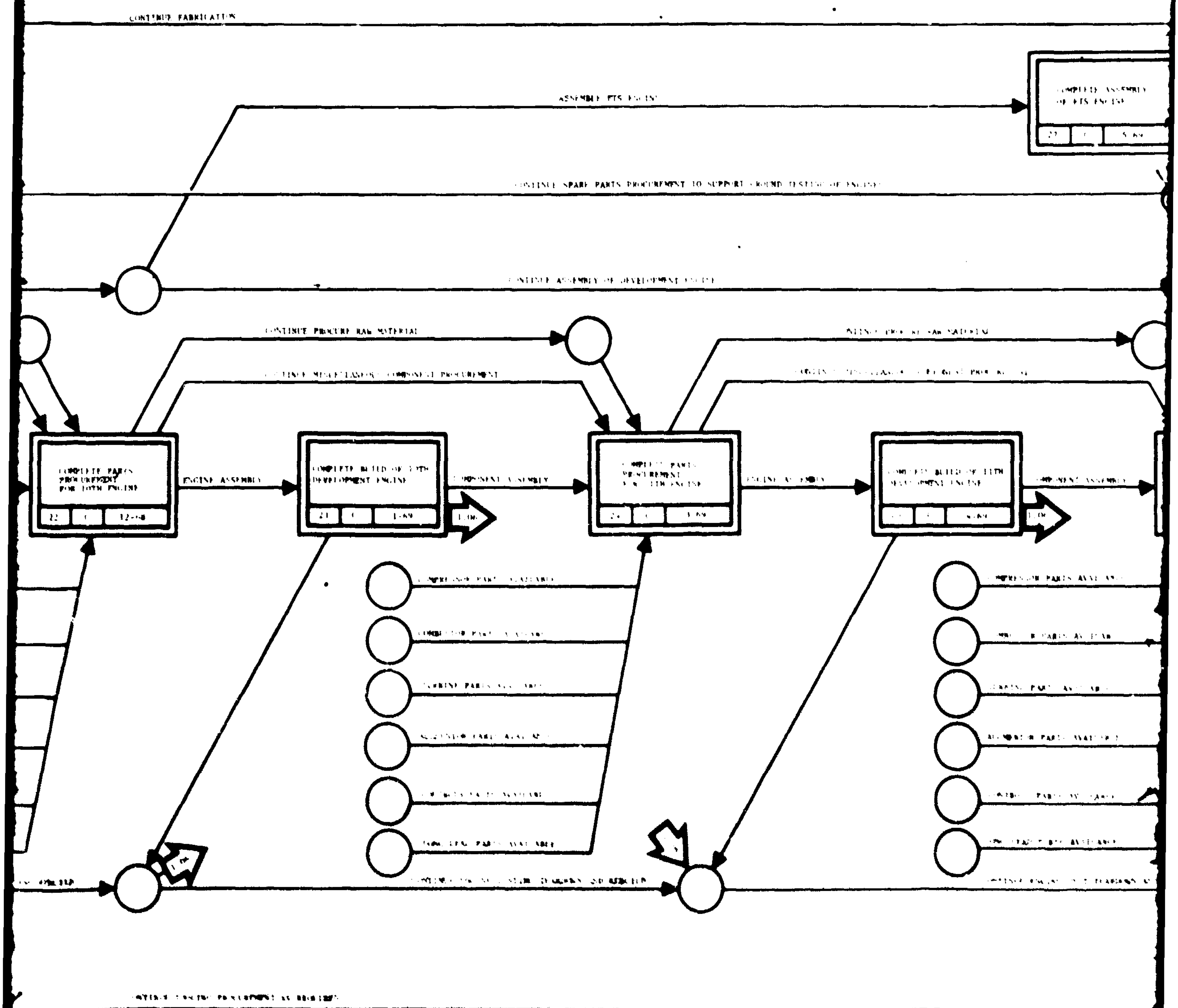
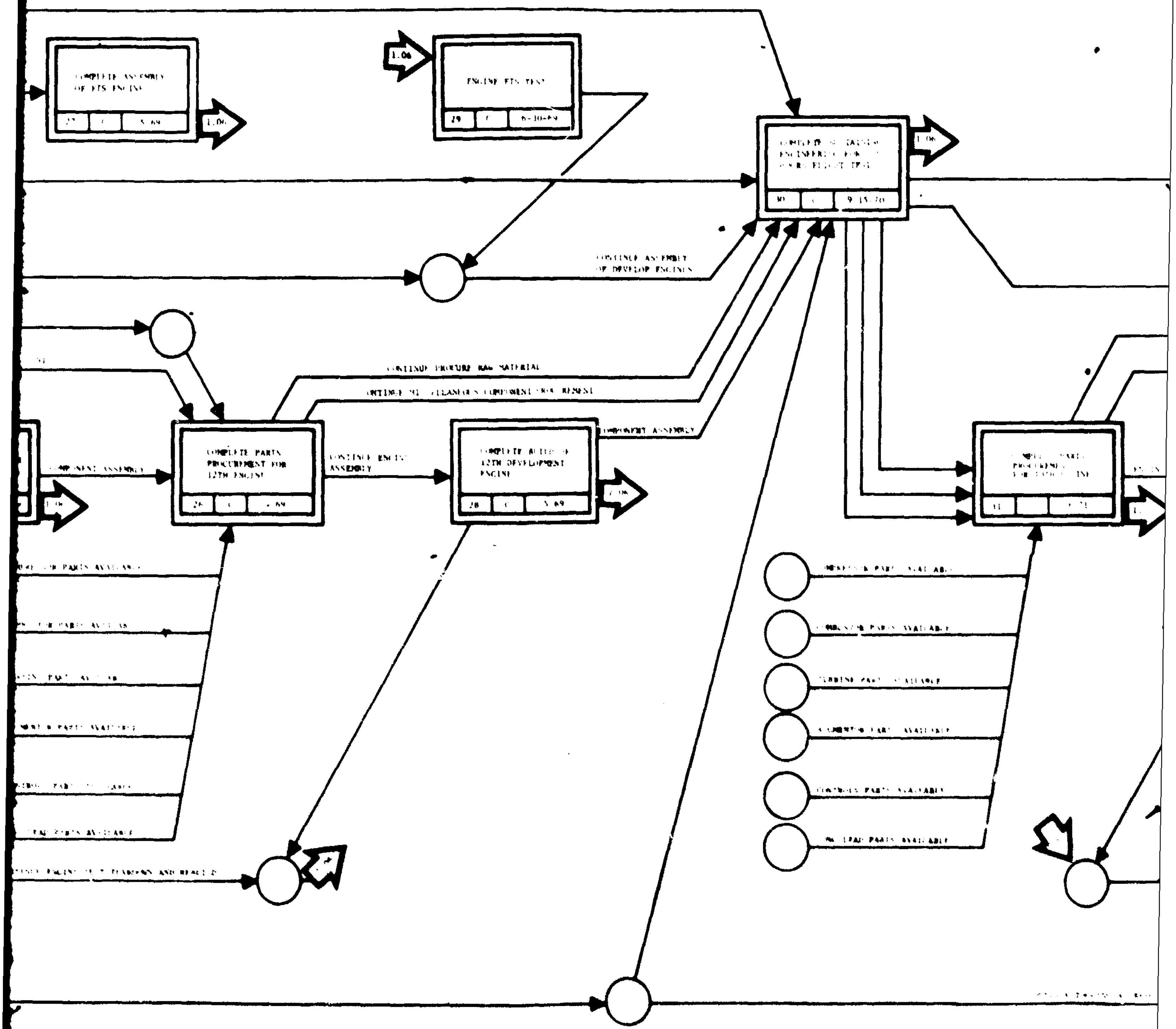
and Assembly





ENGINE CERTIFICATION


CONTINUE FABRICATION
CONTINUE SPARE PARTS PROCUREMENT TO SUPPORT GROUND TESTING OF ENGINE
CONTINUE PROCURE RAW MATERIAL
ENGINE ASSEMBLY
COMPLETE PARTS PROCUREMENT FOR 10TH ENGINE
COMPLETE BUILD OF 10TH DEVELOPMENT ENGINE



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CONTINUE ASSEMBLY
OF DEVELOP ENGINES
CONTINUE PROCURE RAW MATERIAL
COMPLETE PARTS
PROCUREMENT FOR
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ASSEMBLY
COMPLETE BUILD OF
12TH DEVELOPMENT
ENGINE
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COMPONENT ASSEMBLY
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COMPRESSOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
CONTROLS PARTS AVAILABLE

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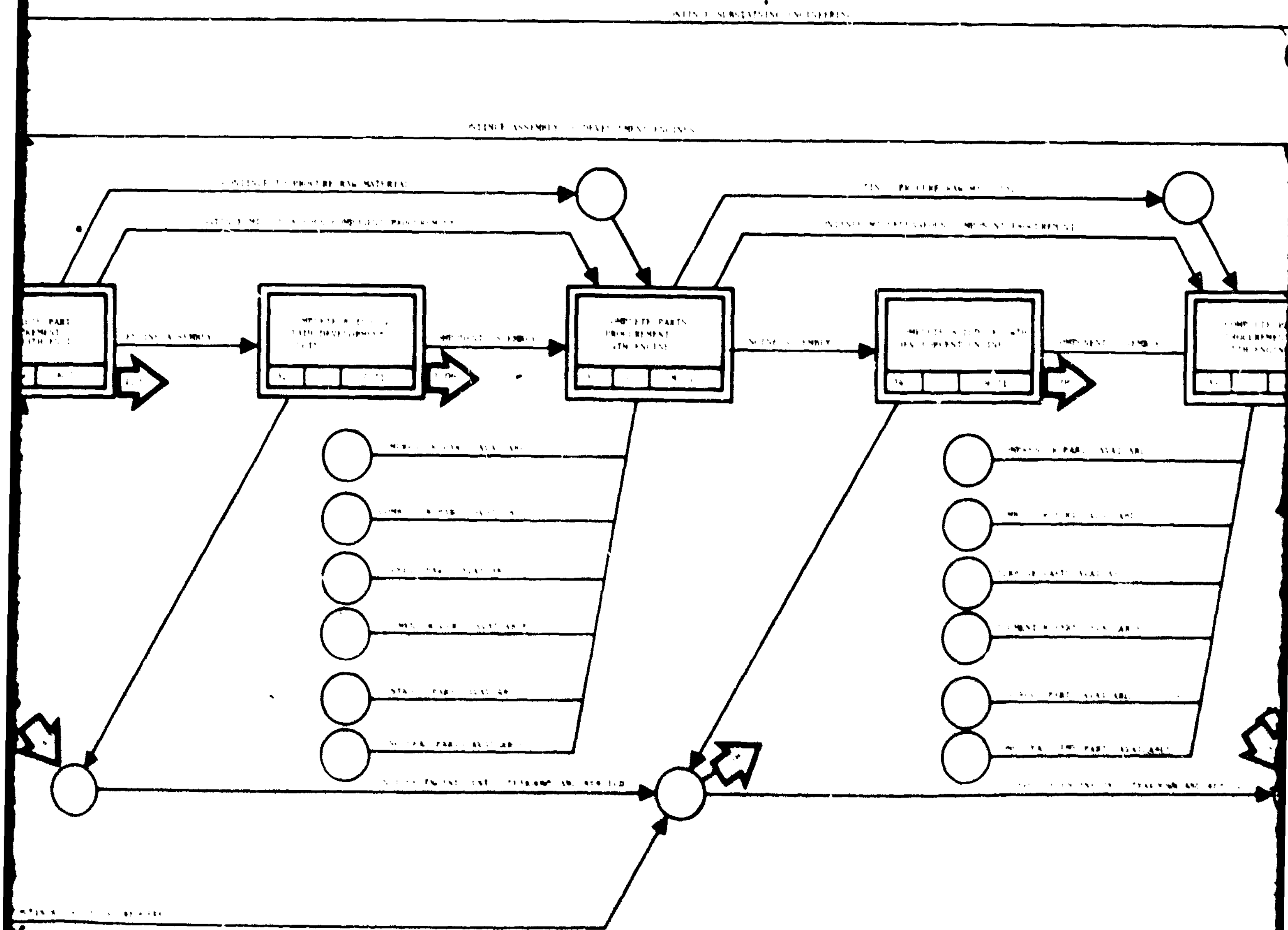

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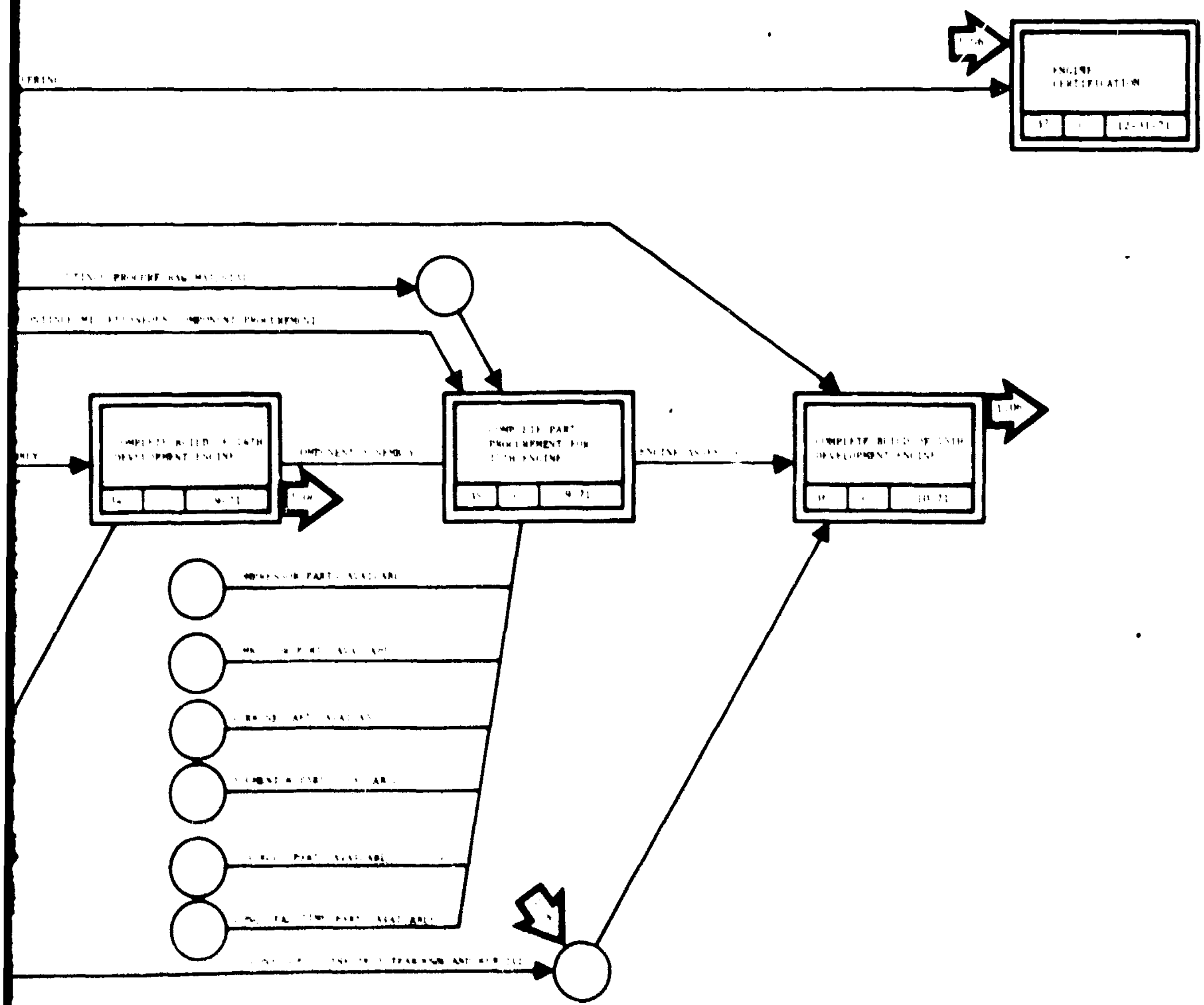
Figure 4.



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1.03 TOOLING

Tooling will be designed, procured, inspected and assembled in quantities to meet the schedules of the JTF17 engine development program. The selection of the degree of tooling will be based on the maximum value in trade-off between labor costs and tooling costs.

Based on experience, engine areas that have a high probability of change are identified, and tooling for such areas is designed as versatile as possible to minimize the cost of obsolescence. Standard tooling and standard methods of gaging are used where possible to reduce the quantity of special tooling required, and to make use of "Catalogue" or shelf-type, low-cost items. Historically, this policy of minimal tooling and gaging for the construction of development engines has proved to be most economical and has resulted in an ability to incorporate Engineering Changes in the minimum time.

The fabrication of development tooling is predominantly subcontracted with the most critical or urgently required tooling being made by Pratt & Whitney Aircraft. New tooling is always thoroughly inspected and tool tryout carefully monitored by the Process Planning and Tool Design Department and Shop personnel to insure that quality requirements are met and that the tool functions as intended.

To determine the type, quantity, and cost of tooling required for the "in-house" manufacturing activity, preliminary drawings will be provided to each process planning group as required. Operation sheets will be prepared denoting operation sequence, description of work to be performed, type of manufacturing equipment to be employed, special tooling required, and a graphic illustration of the operation when necessary for clear direction.

Assembly tooling requirements such as special wrenches, pushers and pullers, balance tooling, spin pit arbors, handling stands, hoists, etc., originate from the Assembly Planning Section of Process Planning from a study of the engine layouts. "Make or Buy" decision, subcontracting, manufacture and inspection are handled in the same manner as other shop tooling.

Subcontractor tooling for the development phase will also be as universal as possible. Tooling requirements can be held to a minimum by manufacturing parts in the subcontractor's experimental shops, utilizing tool room techniques and universal machines. The FRDC Purchasing Department is always in a position to evaluate new tooling requirements for the development phase through updated knowledge of subcontractors equipment and machinery. This assures that changes are accomplished economically.

The major milestones, network chart and event dictionary for tooling are shown in figures 5 and 6, respectively.

A detailed description of tooling is presented in the Test and Certification Plan, Volume III, Report E and the Manufacturing Program, Volume V, Report G. Test planning and integration is presented in Test, Volume IV, Report E.

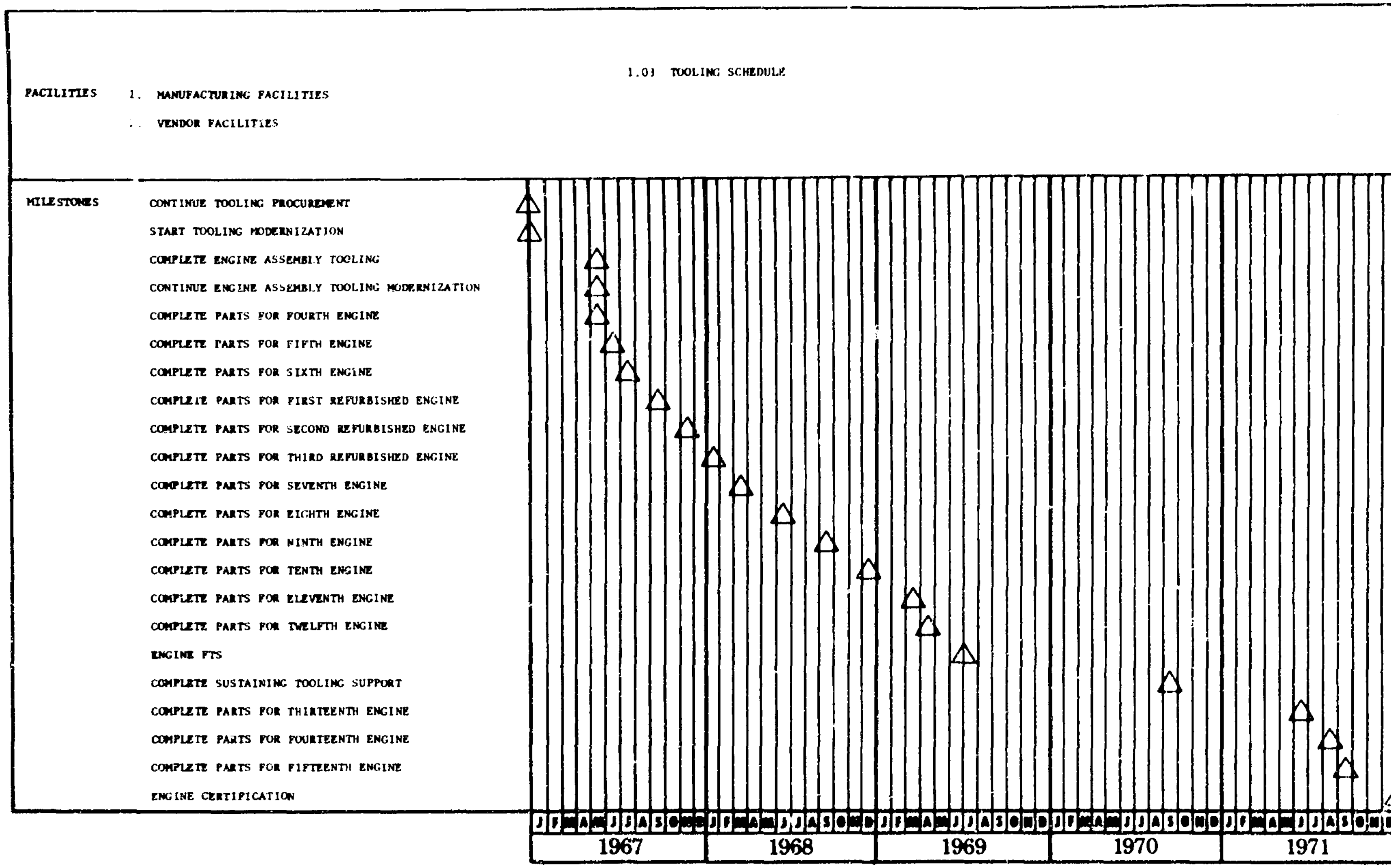

Figure 5. 1.03 Tooling

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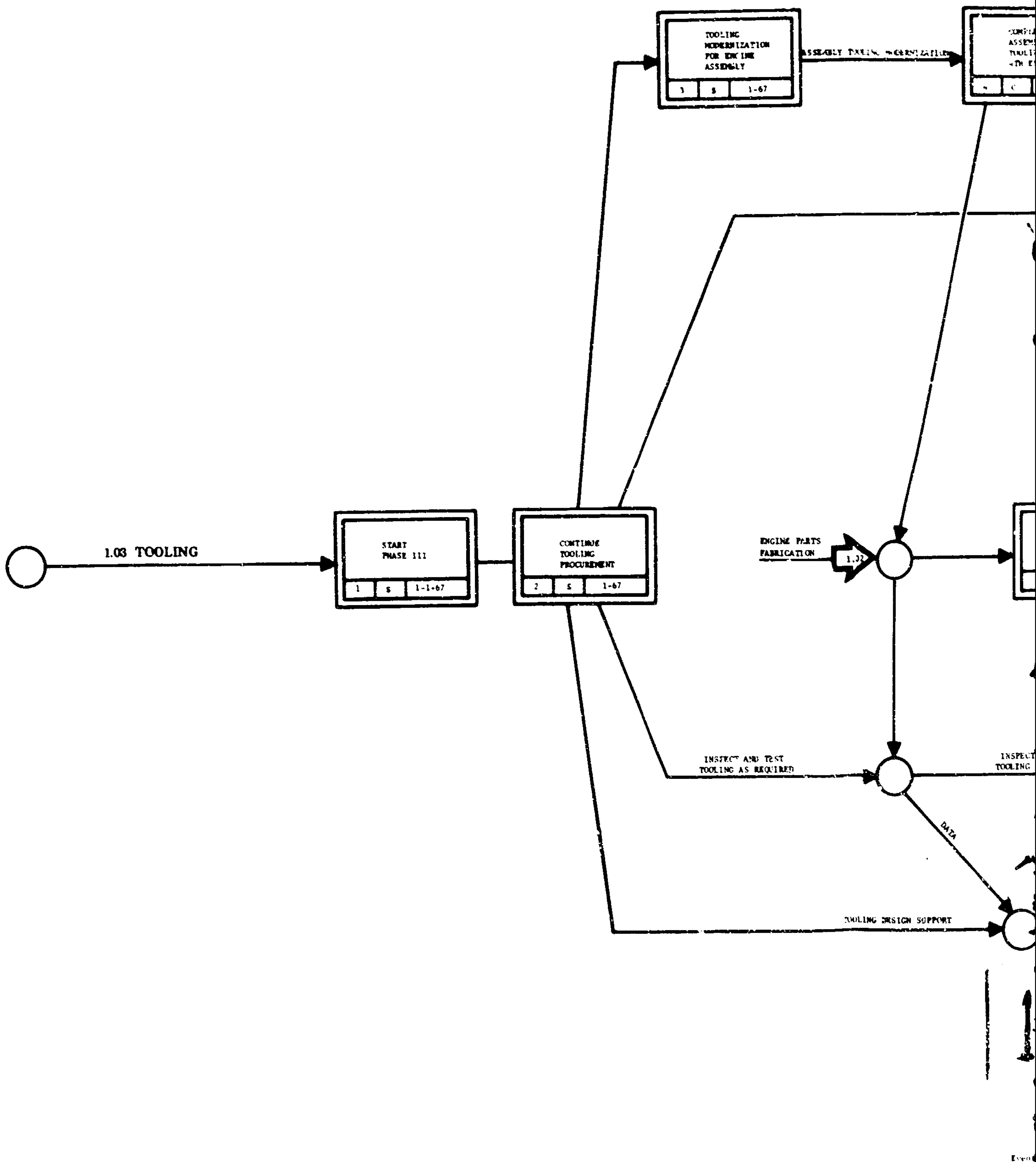
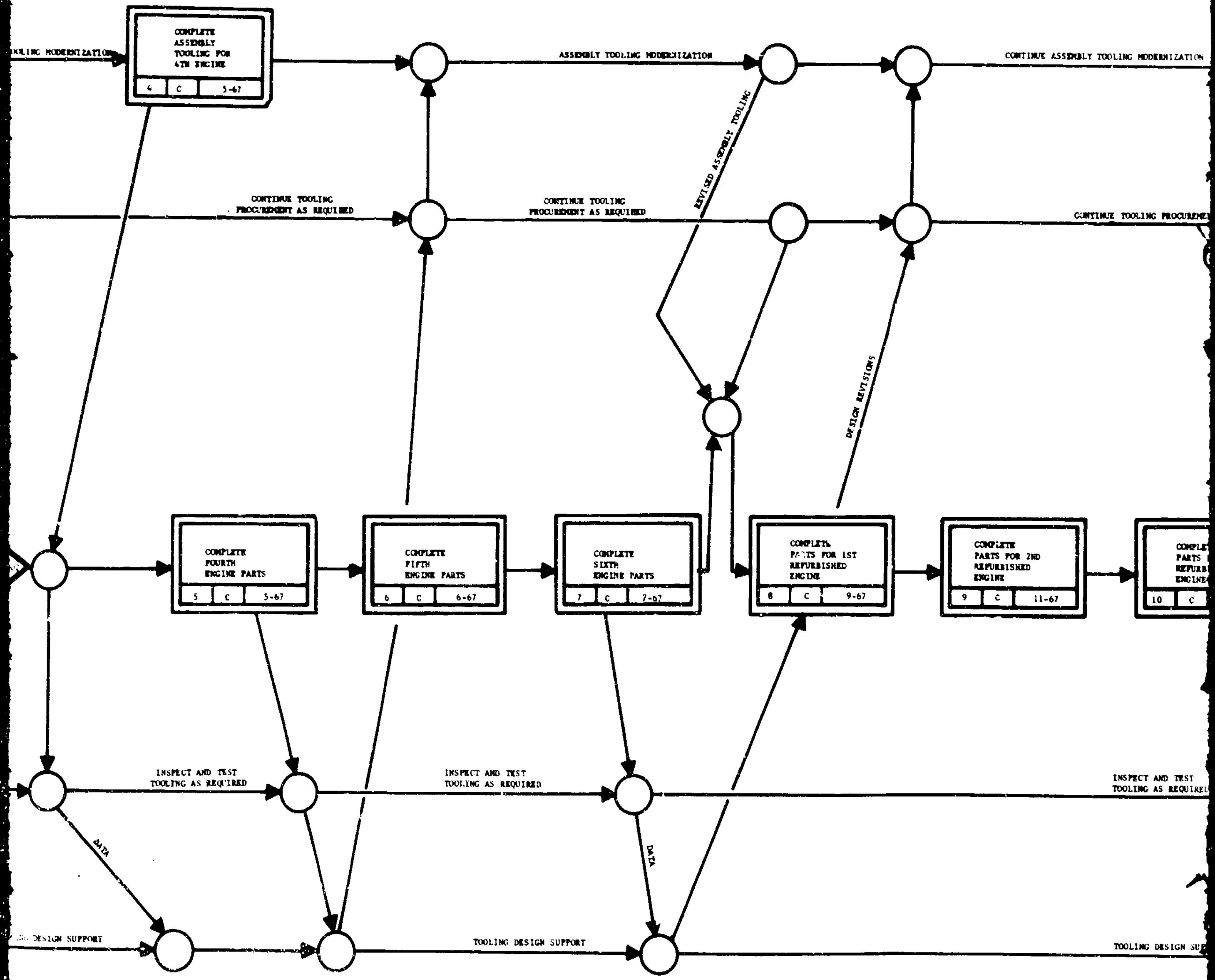


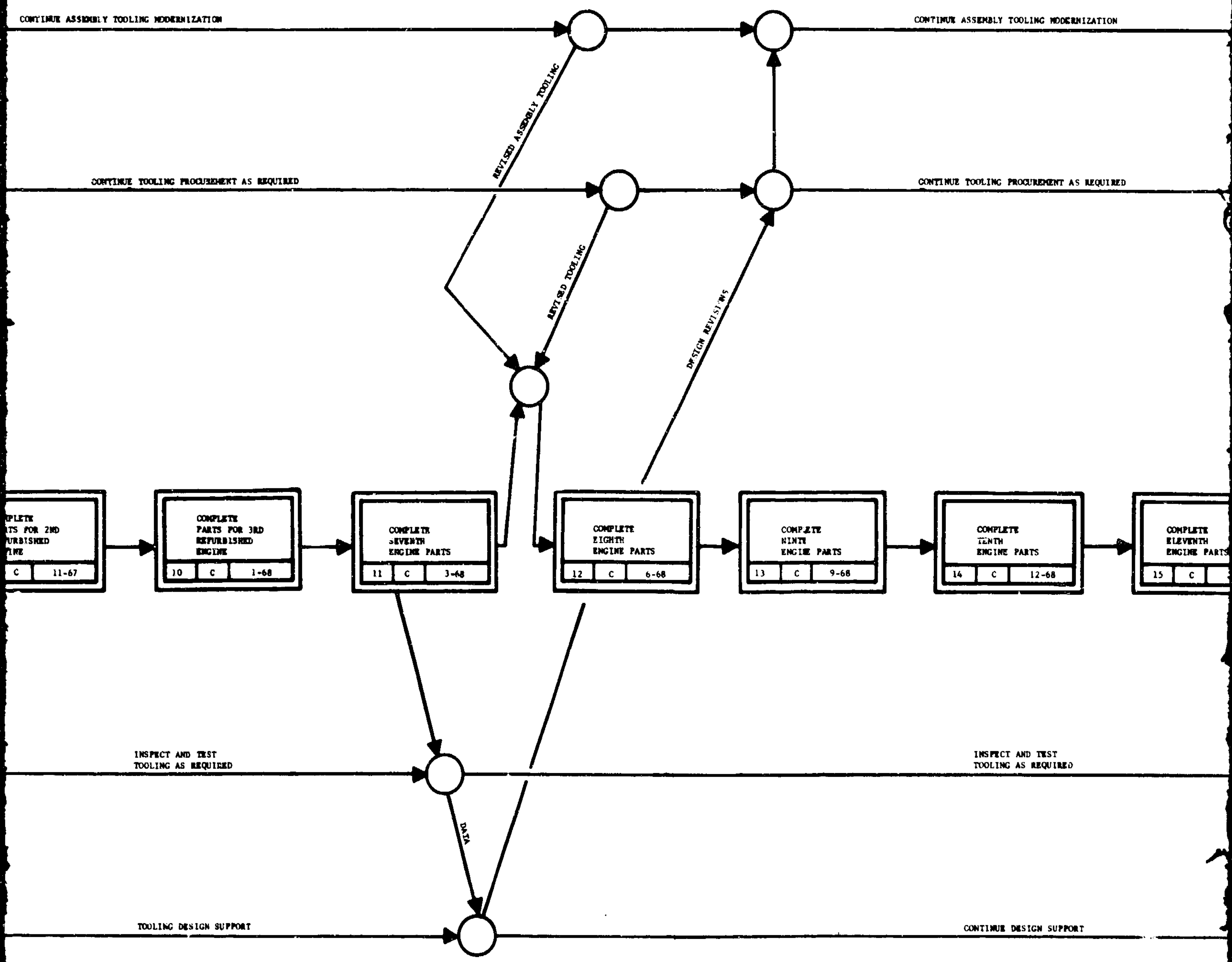
Figure 6. 1.03 Tooling



2

Event Number	Description and Criteria
1	START PHASE III Start of Phase III. Phase III go-ahead received from FAA.
2	CONTINUE TOOLING PROCUREMENT Continue procurement of tooling to fabricate development engine parts. Phase III go-ahead received from FAA.
3	TOOLING MODERNIZATION FOR ENGINE ASSEMBLY Begin modernization of tooling for development engine assembly. Phase III go ahead received from FAA.
4	COMPLETE ASSEMBLY TOOLING FOR 4TH ENGINE Complete manufacture of tooling required for assembly of the 4th engine. Tooling is delivered to Stores or Assembly.
5	COMPLETE 4TH ENGINE PARTS Complete fabrication of parts for 4th development engine. Parts are delivered to Stores or Assembly.
6	COMPLETE 5TH ENGINE PARTS Complete fabrication of parts for 5th development engine. Parts are delivered to Stores or Assembly.
7	COMPLETE 6TH ENGINE PARTS Complete fabrication of parts for 6th development engine. Parts are delivered to Stores or Assembly.
8	COMPLETE PARTS FOR 1ST REFURBISHED ENGINE Complete fabrication of parts for 1st engine to be refurbished. Parts are delivered to Stores or Assembly.

1.03 Tooling



3

th develop- Stores or

th develop- Stores or

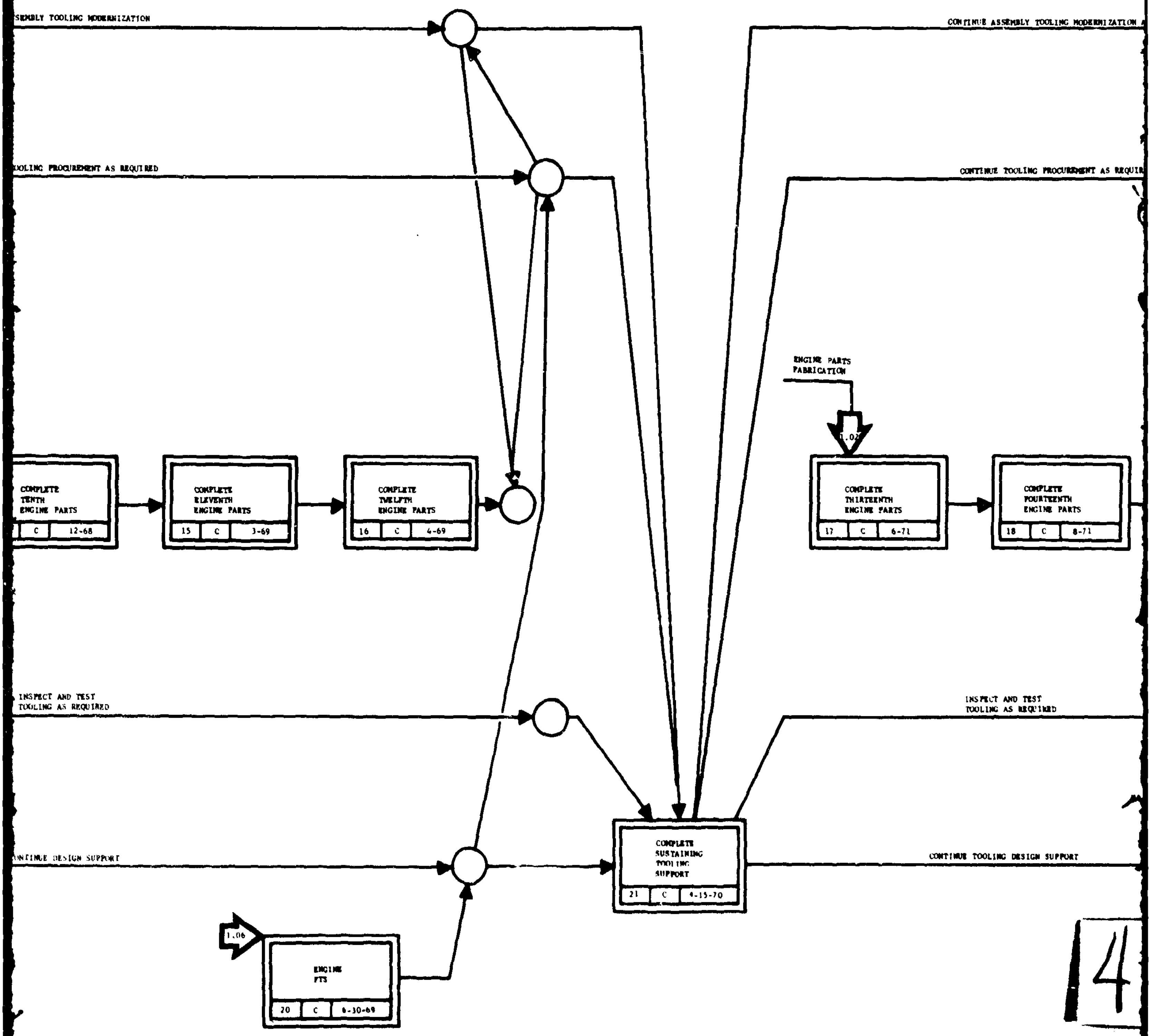
th develop- Stores or

ENGINE
1st engine to
ed to Stores

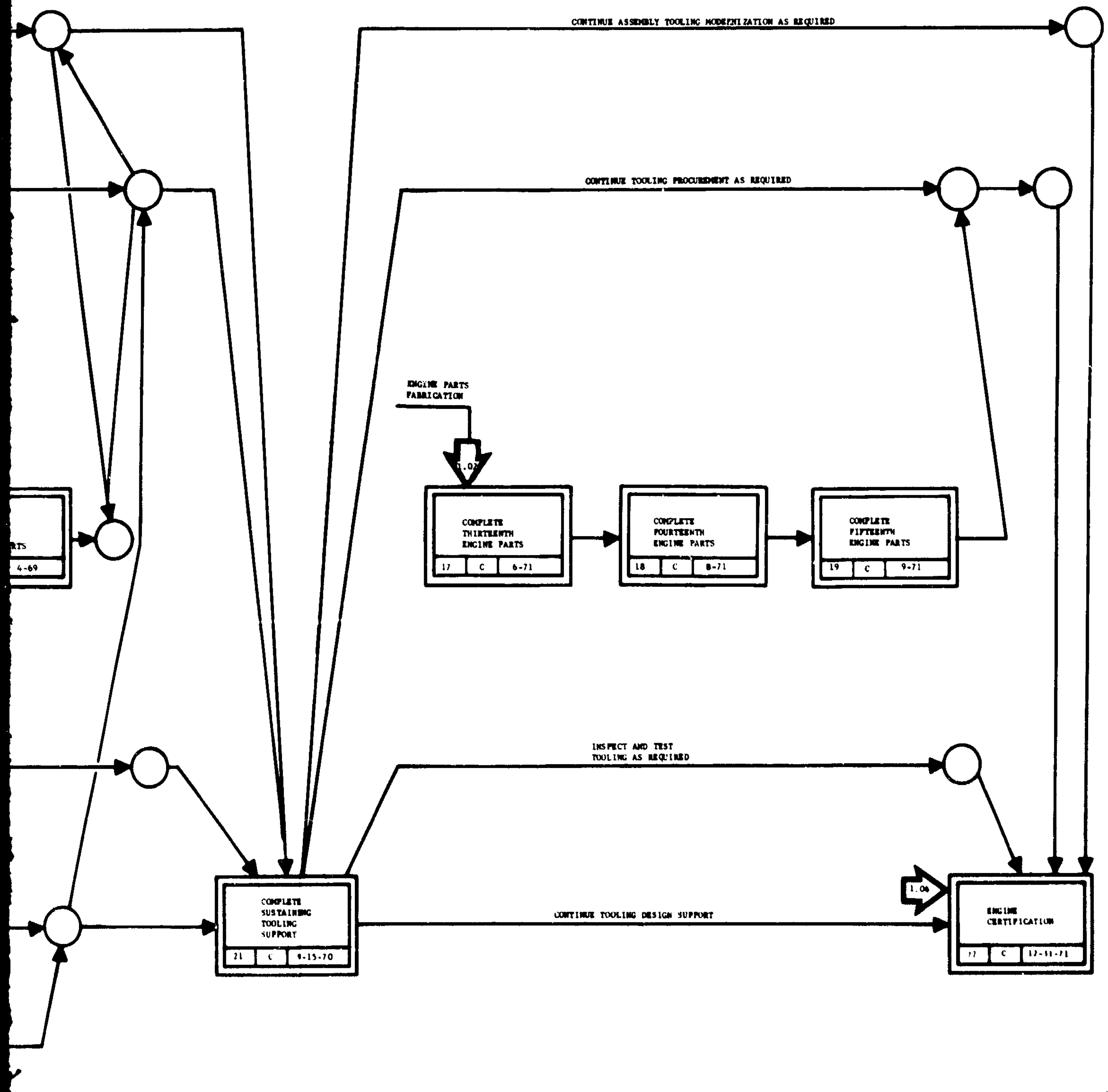
EVENT DICTIONARY
1.03 TOOLING

Event Number	Description and Criteria
9	**COMPLETE PARTS FOR 2ND REFURBISHED ENGINE** Complete fabrication of parts for 2nd engine to be refurbished. Parts are delivered to Stores or Assembly.
10	**COMPLETE PARTS FOR 3RD REFURBISHED ENGINE** Complete fabrication of parts for 3rd engine to be refurbished. Parts are delivered to Stores or Assembly.
11	**COMPLETE 7TH ENGINE PARTS** Complete fabrication of parts for 7th development engine. Parts are delivered to Stores or Assembly.

Event Number	Description and Criteria
12	**COMPLETE 8TH ENGINE PARTS** Complete fabrication of parts for 8th development engine. Parts are delivered to Stores or Assembly.
13	**COMPLETE 9TH ENGINE PARTS** Complete fabrication of parts for 9th development engine. Parts are delivered to Stores or Assembly.
14	**COMPLETE 10TH ENGINE PARTS** Complete fabrication of parts for 10th development engine. Parts are delivered to Stores or Assembly.
15	**COMPLETE 11TH ENGINE PARTS** Complete fabrication of parts for 11th development engine. Parts are delivered to Stores or Assembly.



Description and Criteria	Event Number	Description and Criteria	Event Number	Description and Criteria
...INE PARTS ...ation of parts for 8th develop- ...arts are delivered to Stores or	16	**COMPLETE 12TH ENGINE PARTS** Complete fabrication of parts for 12th develop-ment engine. Parts are delivered to Stores or Assembly.	20	**ENGINE FTS** Reference engine network 1.06 for description and criteria.
...INE PARTS ...tion of parts for 9th develop- ...rts are delivered to Stores or	1	**COMPLETE 13TH ENGINE PARTS** Complete fabrication of parts for 13th develop-ment engine. Parts are delivered to Stores or Assembly	21	**COMPLETE SUSTAINING TOOLING SUPPORT** End of Phase III. Completion of 100 hours of flight testing
...INE PARTS ...on of parts for 10th develop- ...rts are delivered to Stores or	18	**COMPLETE 14TH ENGINE PARTS** Complete fabrication of parts for 14th develop-ment engine. Parts are delivered to Stores or Assembly.	22	**ENGINE CERTIFICATION** Reference engine network 1.06 for description and criteria
...INE PARTS ...ion of parts for 11th develop- ...rts are delivered to Stores or		**COMPLETE 15TH ENGINE PARTS** Complete fabrication of parts for 15th develop-ment engine. Parts are delivered to Stores or Assembly.		



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Description and Criteria	Event Number	Description and Criteria
COMPLETE 12TH ENGINE PARTS Complete fabrication of parts for 12th development engine. Parts are delivered to Stores or Assembly.	20	ENGINE FTS Reference engine network 1.06 for description and criteria
COMPLETE 13TH ENGINE PARTS Complete fabrication of parts for 13th development engine. Parts are delivered to Stores or Assembly	21	COMPLETE SUSTAINING TOOLING SUPPORT End of Phase III. Completion of 100 hours of flight testing
COMPLETE 14TH ENGINE PARTS Complete fabrication of parts for 14th development engine. Parts are delivered to Stores or Assembly	22	ENGINE CERTIFICATION Reference engine network 1.06 for description and criteria.
COMPLETE 15TH ENGINE PARTS Complete fabrication of parts for 15th development engine. Parts are delivered to Stores or Assembly		

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1.04 ENGINE INSTRUMENTATION

The JTF17 engine development requires the accurate measurement of gas and metal temperatures, gas and fluid pressures and flow rates, and thrust. Engine durability requirements necessitate the accurate measurement of vibration, position, and stress data.

In the application of instrumentation the following conditions must be met:

1. Instrumentation must not affect the performance of the engine under test, or alter the properties of the material to which the instrumentation is attached
2. Instrumentation must provide data of sufficient accuracy to satisfy the test requirements
3. Instrumentation must be durable enough to provide data for a period of time commensurate with objectives.

The development of advanced turbofan engines, such as the TF33-P-7, JT8D, and the high Mach number J58, have made it necessary to maintain a high-level program of instrumentation development. The techniques and experience acquired in the development of these engines are now available for the JTF17 engine program.

The JTF17 engine will be equipped with a flight instrumentation system capable of providing accurate and reliable indications of critical engine parameters for airframe readout, ground checkout, and use in the Airborne Integrated Data System. The accuracy, response rate, and signal level characteristics for this instrumentation will be coordinated with the airframe manufacturer and airlines during Phase III to assure compatibility with the airframe systems and engine functions requiring monitoring. The JTF17 engine provides the instrumentation to measure the following parameters:

1. Turbine exhaust pressure
2. Turbine exhaust gas temperature
3. Duct heater nozzle position
4. Reverser-suppressor position
5. Aerodynamic brake position
6. Secondary air valve position
7. Low rotor speed.

In addition, the engine has provisions for the installation of the following instrumentation:

1. High rotor speed tachometer
2. Oil-in temperature
3. Oil pressure
4. Primary gas generator fuel flowmeter
5. Duct heater fuel flowmeter
6. Oil filter differential pressure
7. Fuel filter differential pressure
8. Vibration pickup mounting brackets (2)
9. Fuel pump inlet pressure
10. Fuel pump inlet temperature.

The flight instrumentation components provide airframe connectors as indicated on the Installation Drawing. These components are mounted directly on the engine and are exposed to high ambient temperatures, engine vibrations, and acoustical noise. Accordingly, they will be subjected to thorough development programs as individual units and as part of the complete engine system.

Component testing will be conducted at P&WA and the vendor facility to develop each component to meet its requirements of simplicity, accuracy, reliability, and maintainability. These tests will include electrical outputs, vibrations, acoustics, environmental, special tests of electrical interference generation and susceptibility, explosion proof, humidity, and impact.

Automated digital data systems have been applied to jet engine development testing at FRDC since 1958. Two data systems, serving engine and component test stands, have produced an average of 2.6 million data points per month over the last two years. Reliable and consistent data have been taken at environmental conditions in excess of Mach 3.0. Included as a part of the systems is an on-line computer used to process raw data into engineering units. Computed performance parameters such as TSFC, simulated altitude, Mach number, exhaust gas temperature, EGT profiles, component efficiencies, and airflow are displayed to the test stand control room while the test is in progress within two to three minutes from the time of recording.

The Instrument Laboratory is equipped and staffed to develop, maintain, and calibrate all types of precision instruments required for propulsion system, component development, and performance measurements. Equipment is available for measuring and recording fuel flow, thrust, speed, pressure, vibration stress, chemical composition, heat transfer, and numerous other variables associated with powerplant evaluations.

The engineering staff provides the technical direction for the work of the Instrument Laboratory, has responsibility for providing all necessary specialized measuring instruments, plans and supervises the assembly of complex measurement and recording systems, and does the actual measurement and analysis in cases where specialized experience is necessary.

The major milestones, network chart and event dictionary for engine instrumentation are shown in figures 7 and 8, respectively.

A detailed description of engine instrumentation is presented in the Test and Certification Plan, Volume III, Report E. Test planning and integration is presented in Test, Volume IV, Report E.

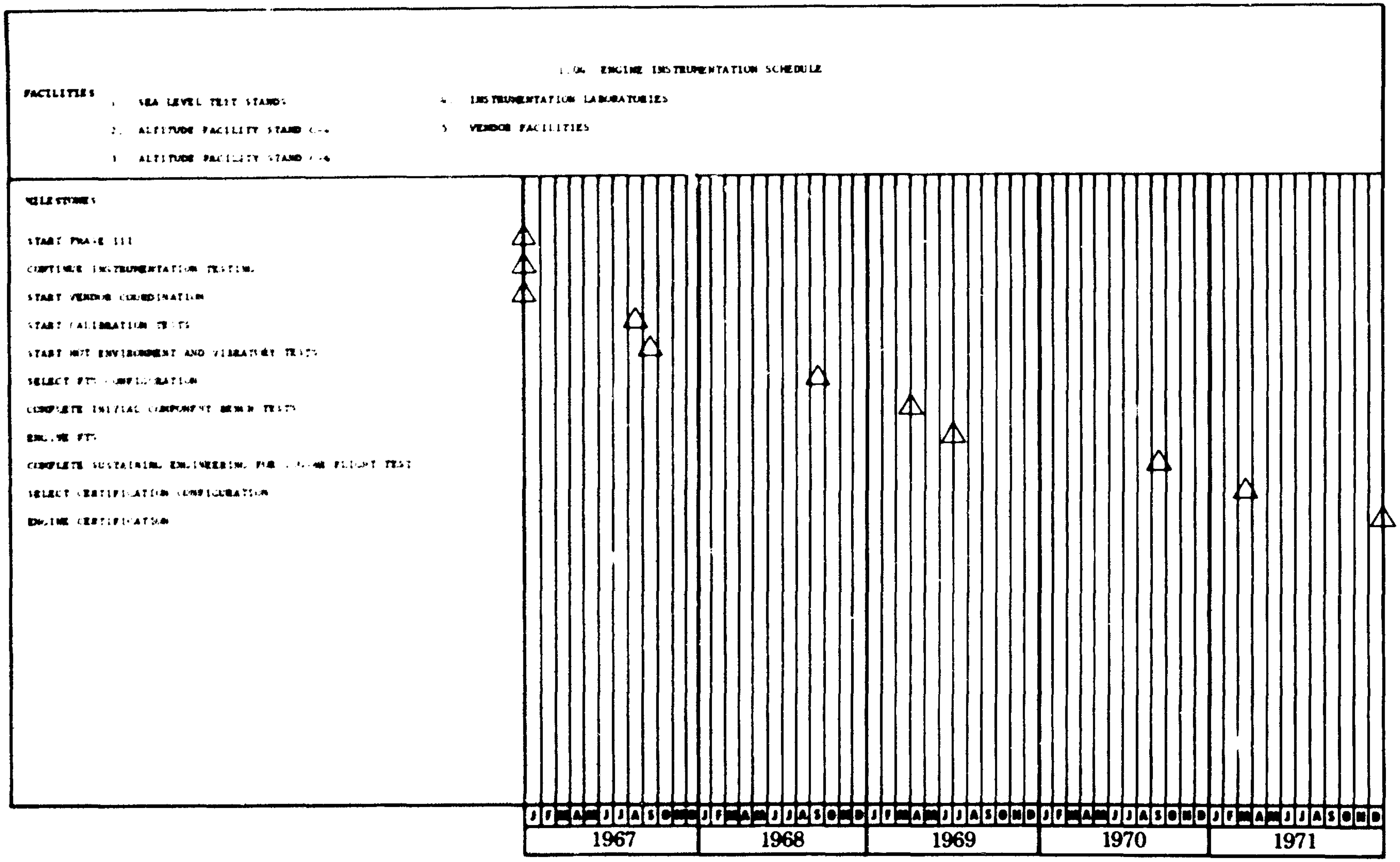

Figure 7. 1.04 Engine Instrumentation

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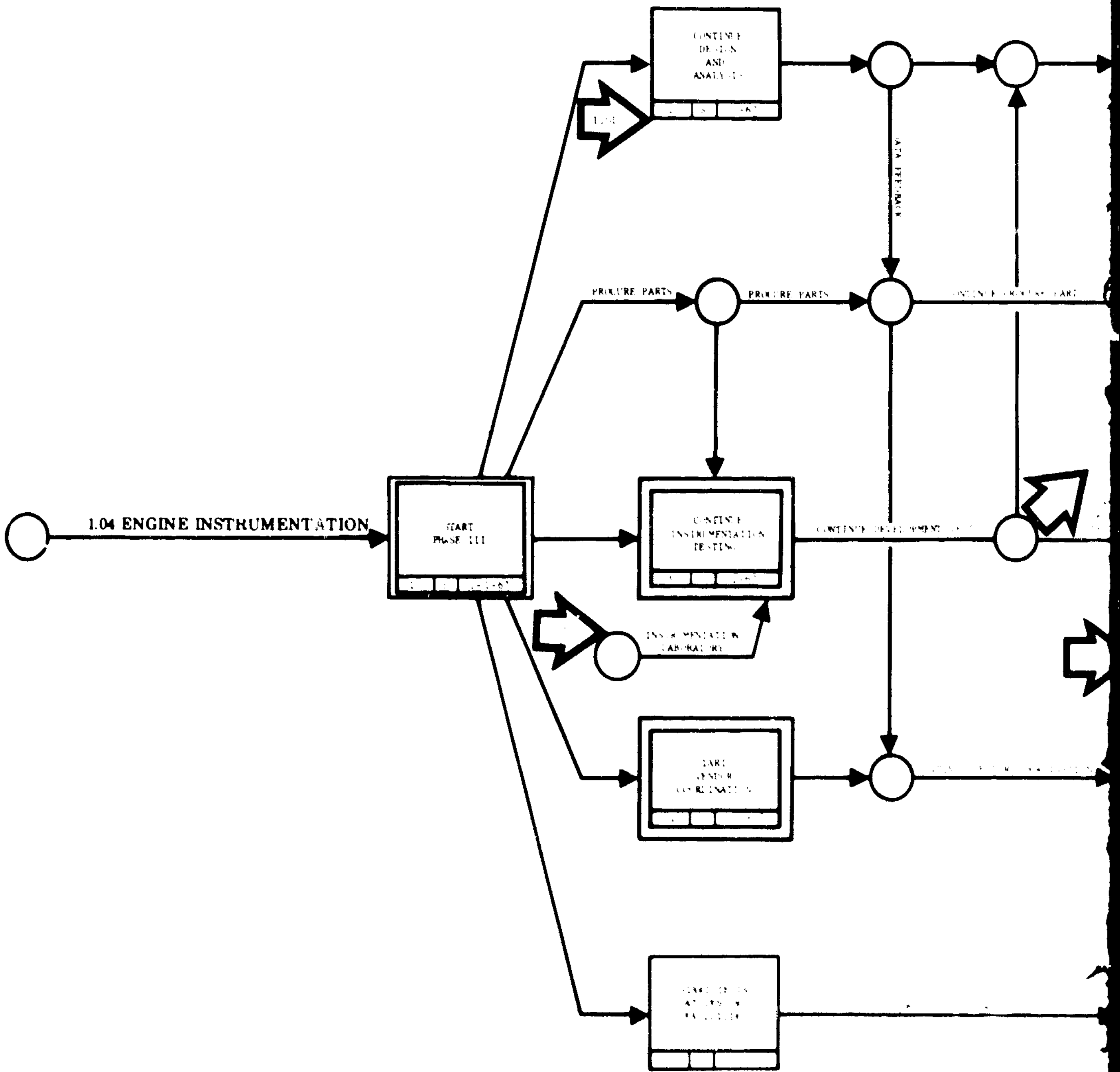
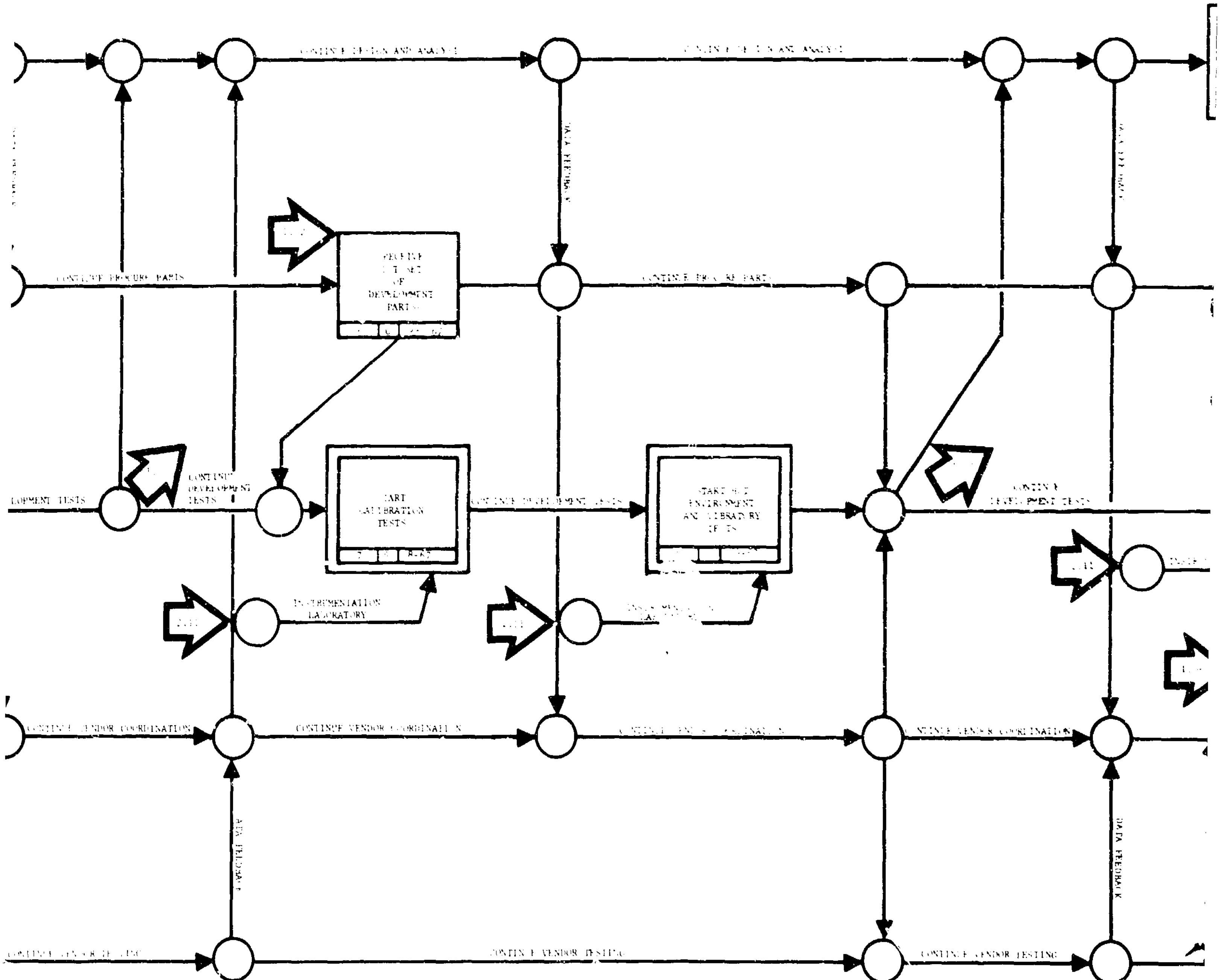
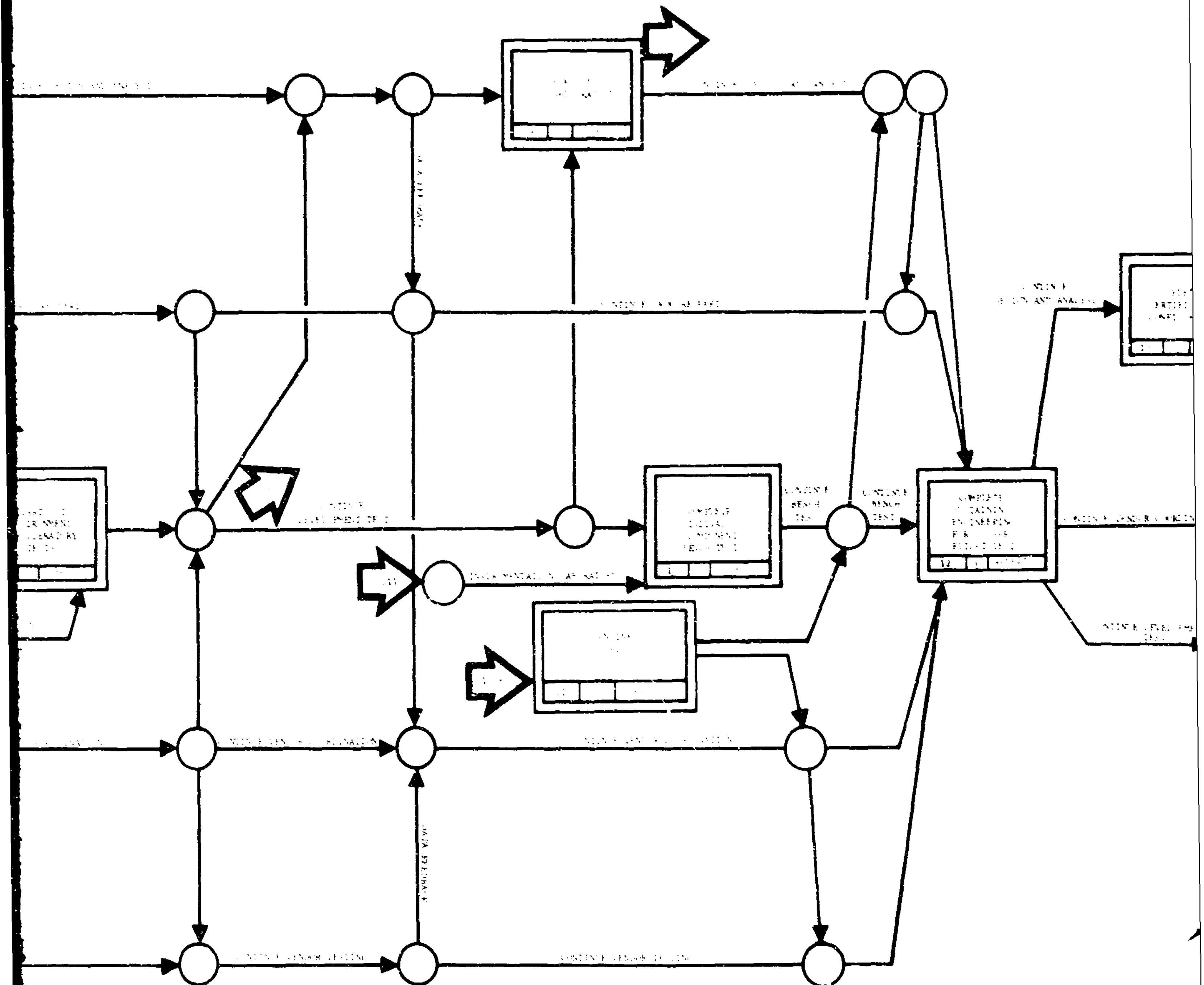

1.04 ENGINE INSTRUMENTATION
PROCURE PARTS
PROCURE PARTS

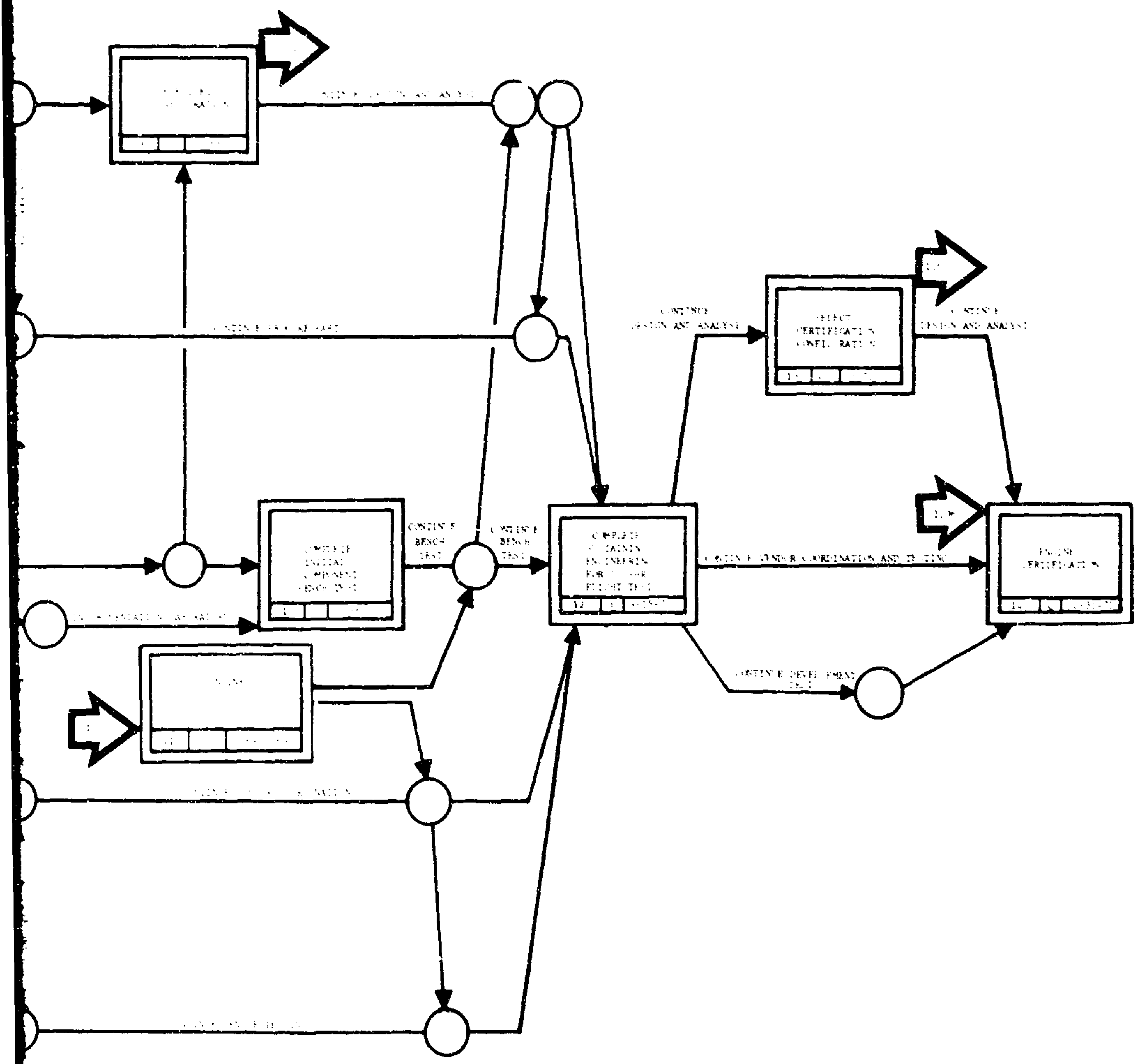
1.04 Engine Instrumentation



Event Number	Description and Criteria

strumentation





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1.05 TEST EQUIPMENT

Facilities Engineering provides the necessary test facilities required to meet test requirements outlined in Phase III of the Supersonic Transport engine program. A complete description of the facilities utilized in Phase III for the JTF17 engine program is contained in Volume V, Report B. Responsibilities of Facilities Engineering are as indicated below:

1. Facilities Engineering have under their cognizance a Facilities Design Engineering Group responsible for P&WA facility designs, and for the development of design criteria for distribution to architectural engineering firms.

2. Once the design of a facility is established, it is the responsibility of Facility Engineering to initiate procurement through a Materials Control Group, utilizing Government reserve equipment screening where available through DIPEC.

3. Installation of all test equipment is accomplished by separate purchase order to an installation contractor, under the direction of the responsible Facility Engineer.

4. Checkout and inspection of all test equipment is under the supervision of Facilities Engineering during the final phase of construction, in coordination with the Inspection and Test Operation Departments.

The test stands utilized in Phase III of the JTF17 engine program are as follows.

A. Sea Level Engine Calibration and Endurance Test Facilities

A total of nine sea level test stands are required to conduct the JTF17 engine program, including three with heated inlet capability. Five existing FRDC stands will be available and capable, with modifications, of testing the JTF17 engine. These stands are A-3, A-4, A-5, A-6, and A-7. Four new stands, A-9, C-8, C-9, and C-10 will be built.

B. Simulated Altitude and Mach Number Engine Test Facilities

A total of three simulated altitude and Mach number engine test facilities are necessary to conduct the testing required for the JTF17 engine program. In these facilities, flight envelope conditions can be simulated. At FRDC one existing test stand is available for testing the JTF17 engine and one new test stand, C-6, will be constructed. One existing stand in the Andrew Willgoos Turbine Laboratory, X-210, will be modified to conduct testing on the JTF17 engine.

C. Simulated Altitude and Mach Number Component Test Facilities

1. Fan and Compressor Facilities

Two full-scale fan and compressor test stands are necessary for the JTF17 program. Each will be capable of testing single-stage, multistage, and complete compressor units over a wide range of simulated altitude and Mach number conditions. One existing test stand, C-3, will be available for the JTF17 program. An additional stand, C-7, will be constructed.

2. Turbine Rig Test Stands (Available)

Two test stands are available for turbine component testing for the JTF17 program. These stands are used to investigate and develop turbine blade and vane materials and cooling configurations.

D. Small Components Facilities

Twenty-eight small component stands and benches will be used for the JTF17 program. They will be used in testing complete control systems and subcomponents, ignition systems and such mechanical components as oil pumps, gearboxes, bearing and seal systems and other engine auxiliary equipment.

The major milestones, network chart and event dictionary for test equipment are shown in figures 9 and 10, respectively.

A detailed description of test equipment is presented in the Facilities Program, Volume V, Report B. Test planning and integration of the test equipment is presented in Test, Volume IV, Report E.

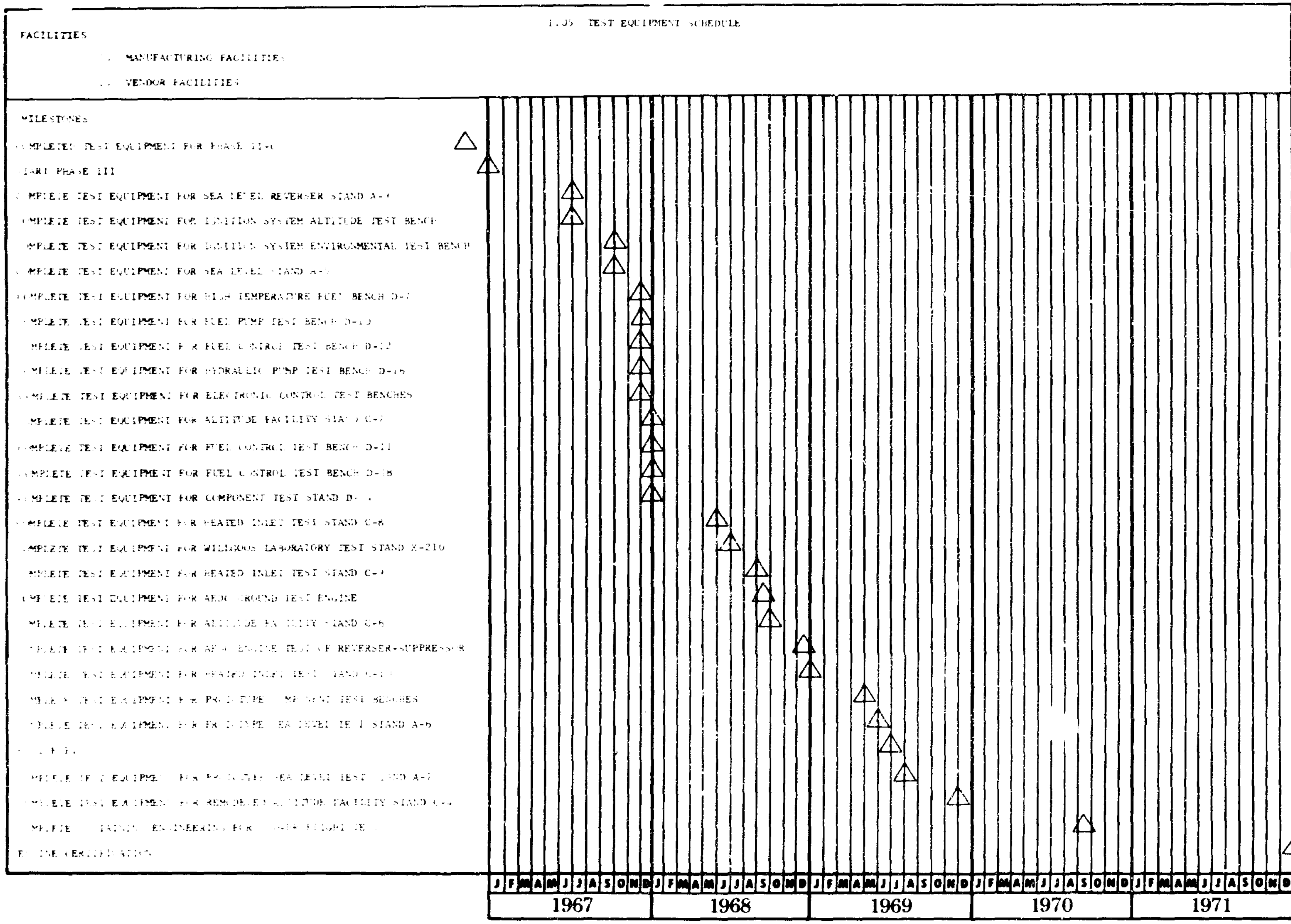

Figure 9. 1.05 Test Equipment

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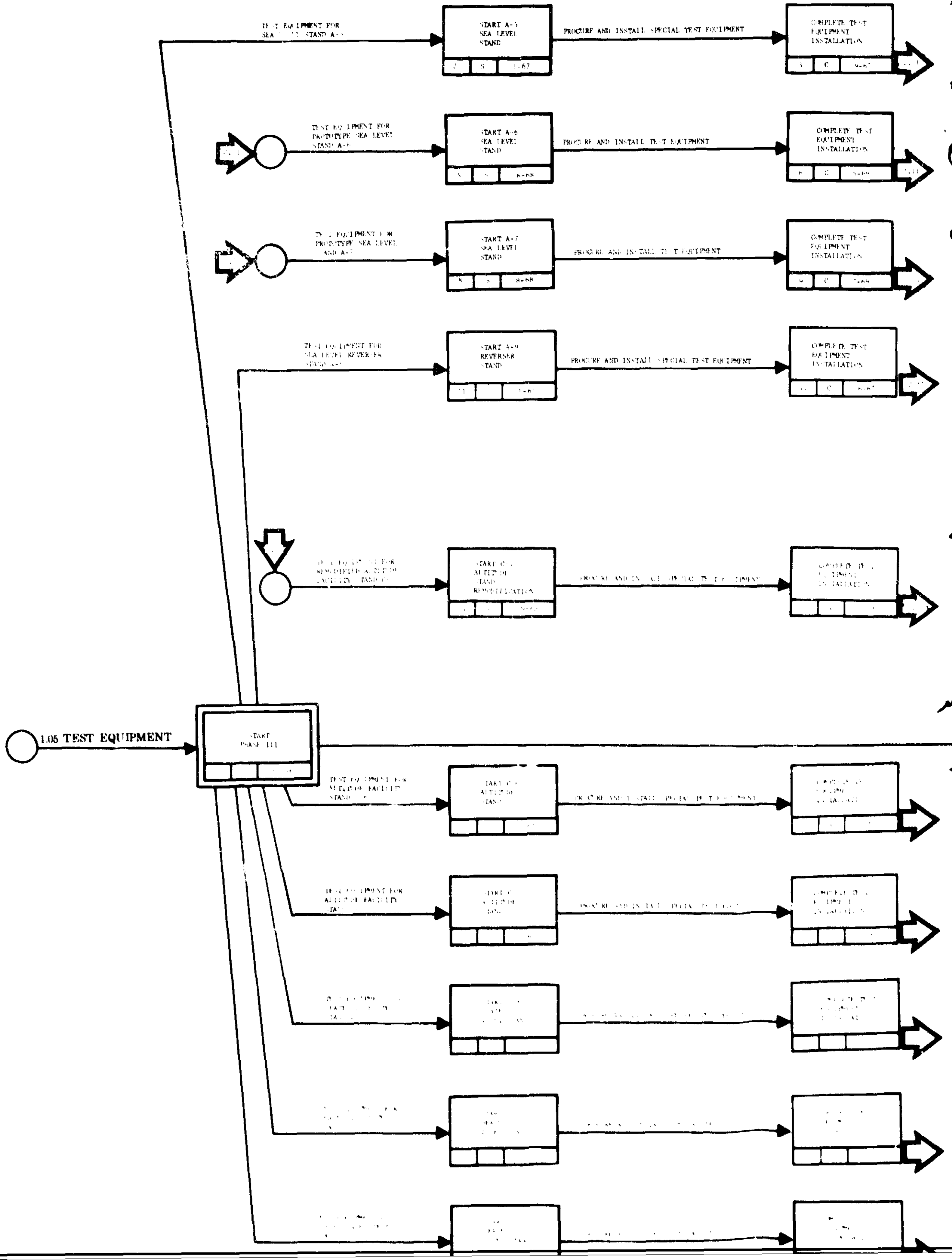
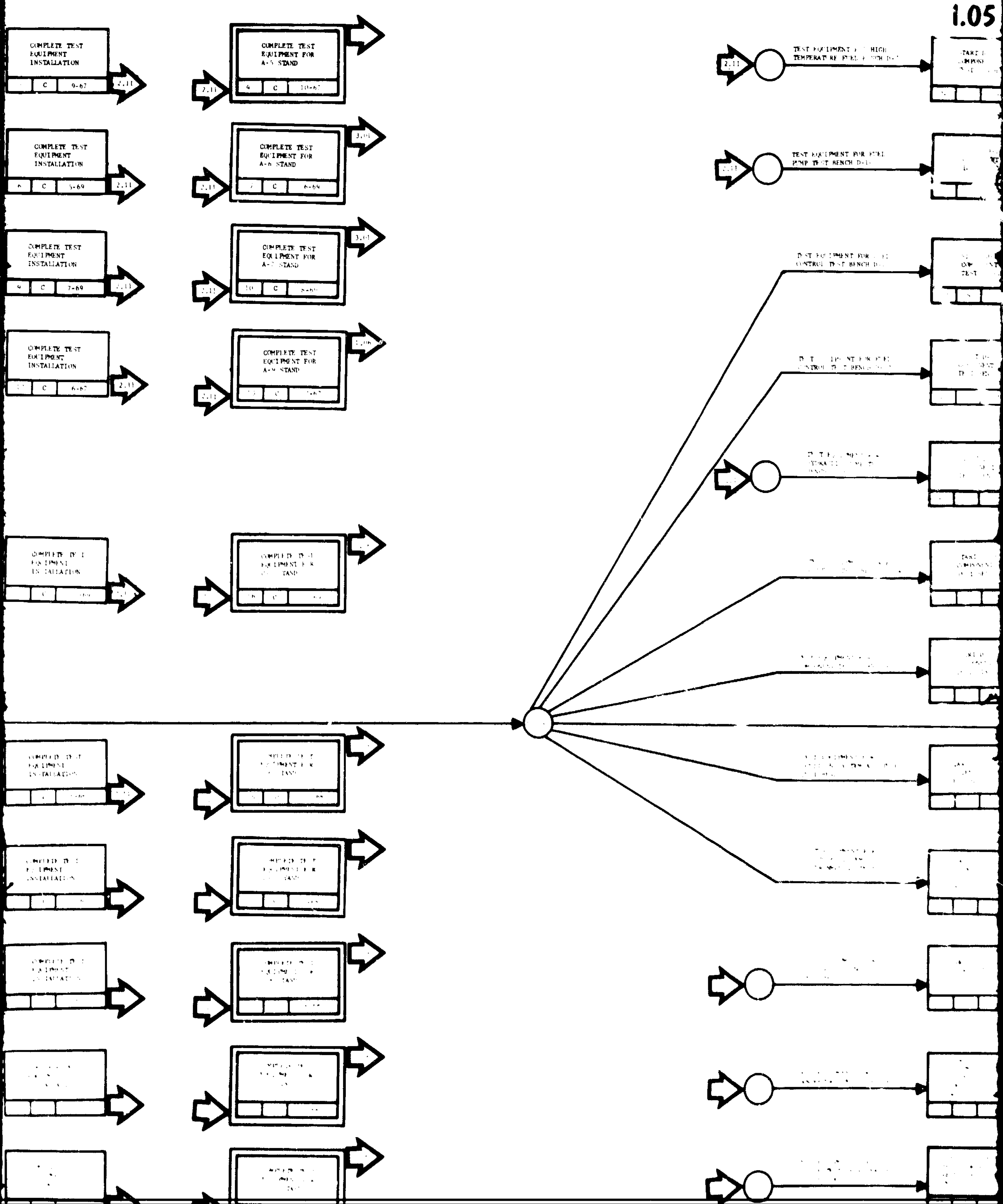


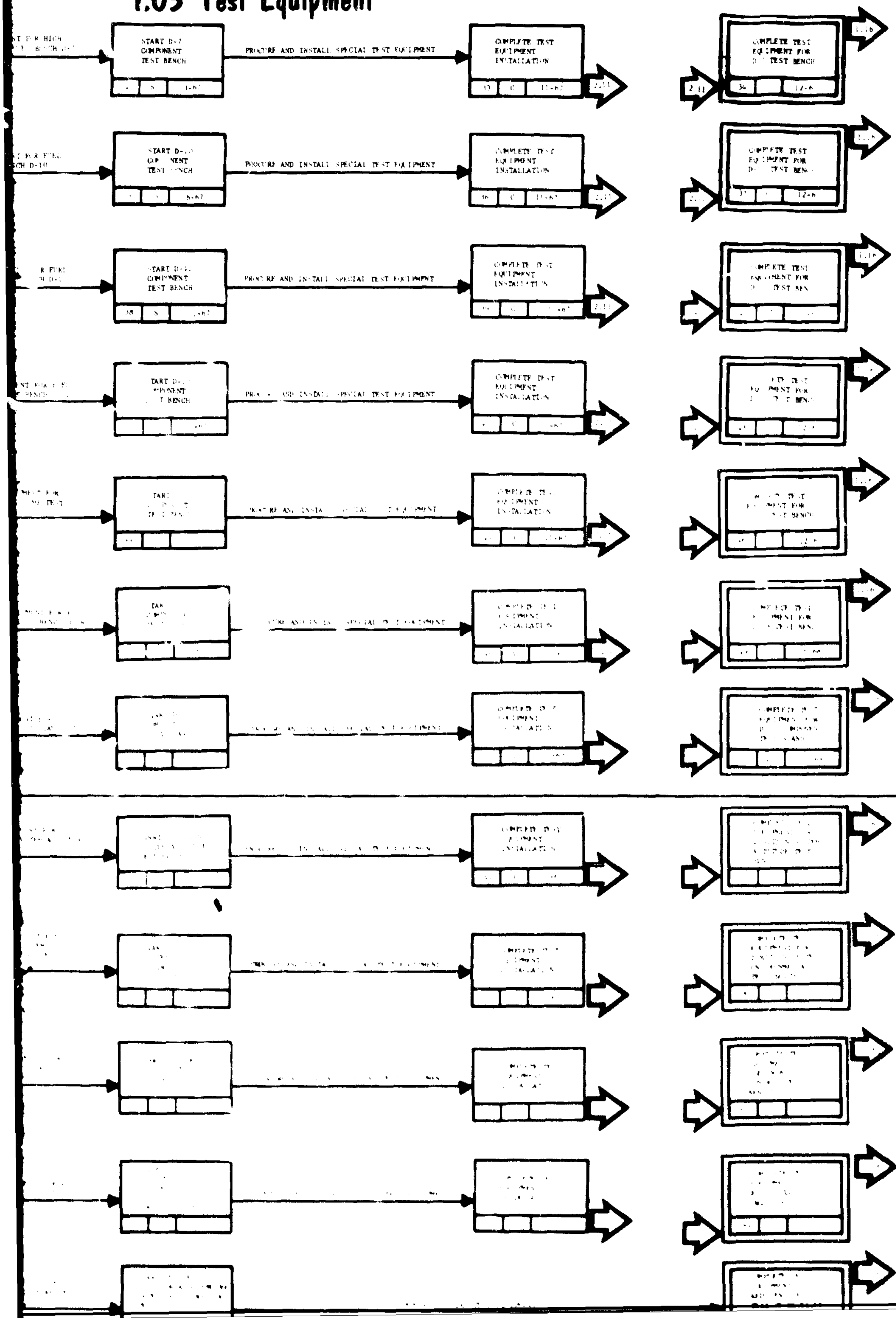
1.06 TEST EQUIPMENT
START A-5
SEA LEVEL
STAND
PROCURE AND INSTALL SPECIAL TEST EQUIPMENT
COMPLETE TEST
EQUIPMENT
INSTALLATION
TEST EQUIPMENT FOR
PROTOTYPE SEA LEVEL
START A-6
SEA LEVEL
STAND
PROCURE AND INSTALL TEST EQUIPMENT
COMPLETE TEST
EQUIPMENT
INSTALLATION
START A-7
SEA LEVEL
STAND
COMPLETE TEST
EQUIPMENT
INSTALLATION
START A-9
REVERSER
STAND
PROCURE AND INSTALL SPECIAL TEST EQUIPMENT
COMPLETE TEST
EQUIPMENT
INSTALLATION

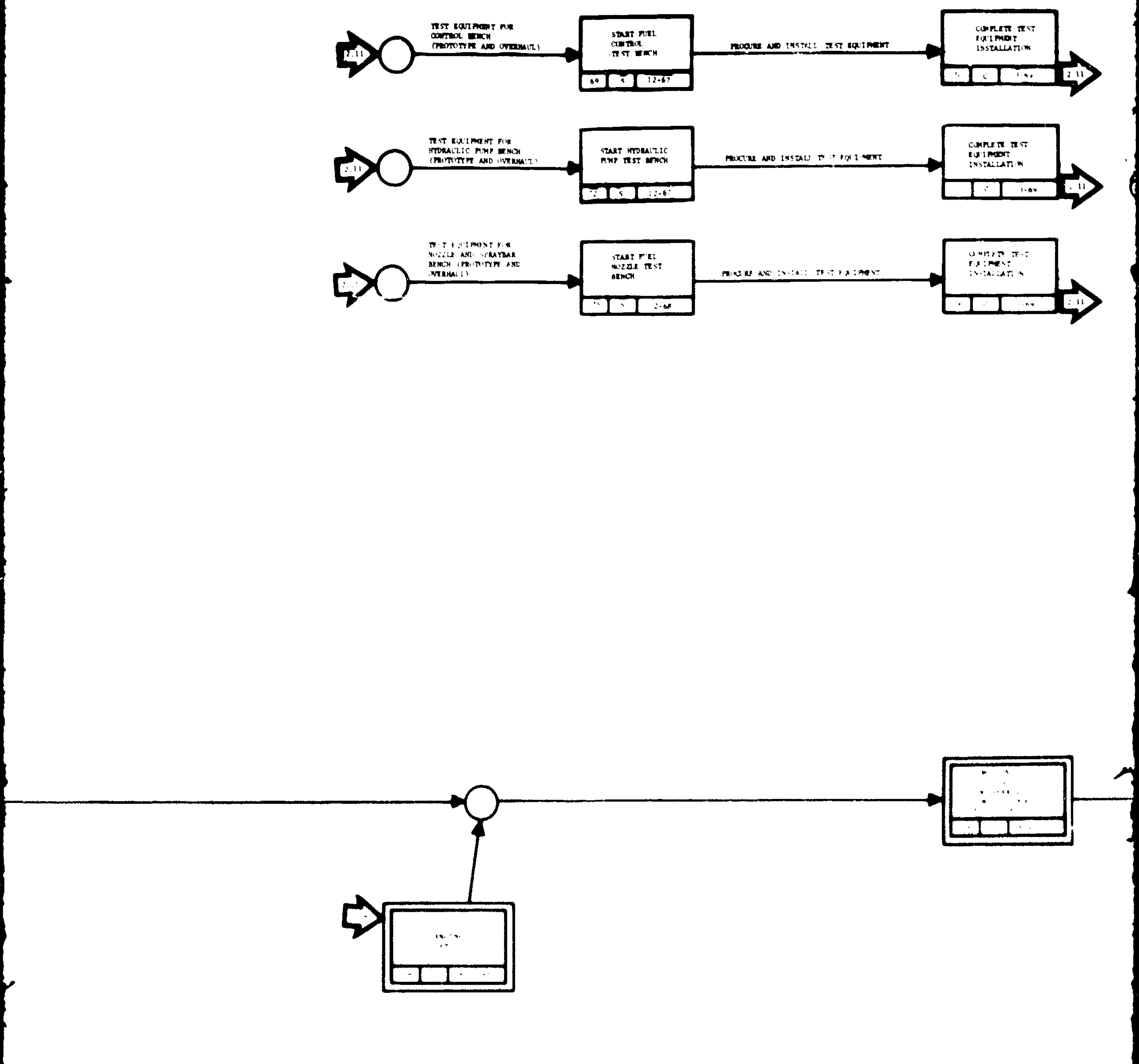
2

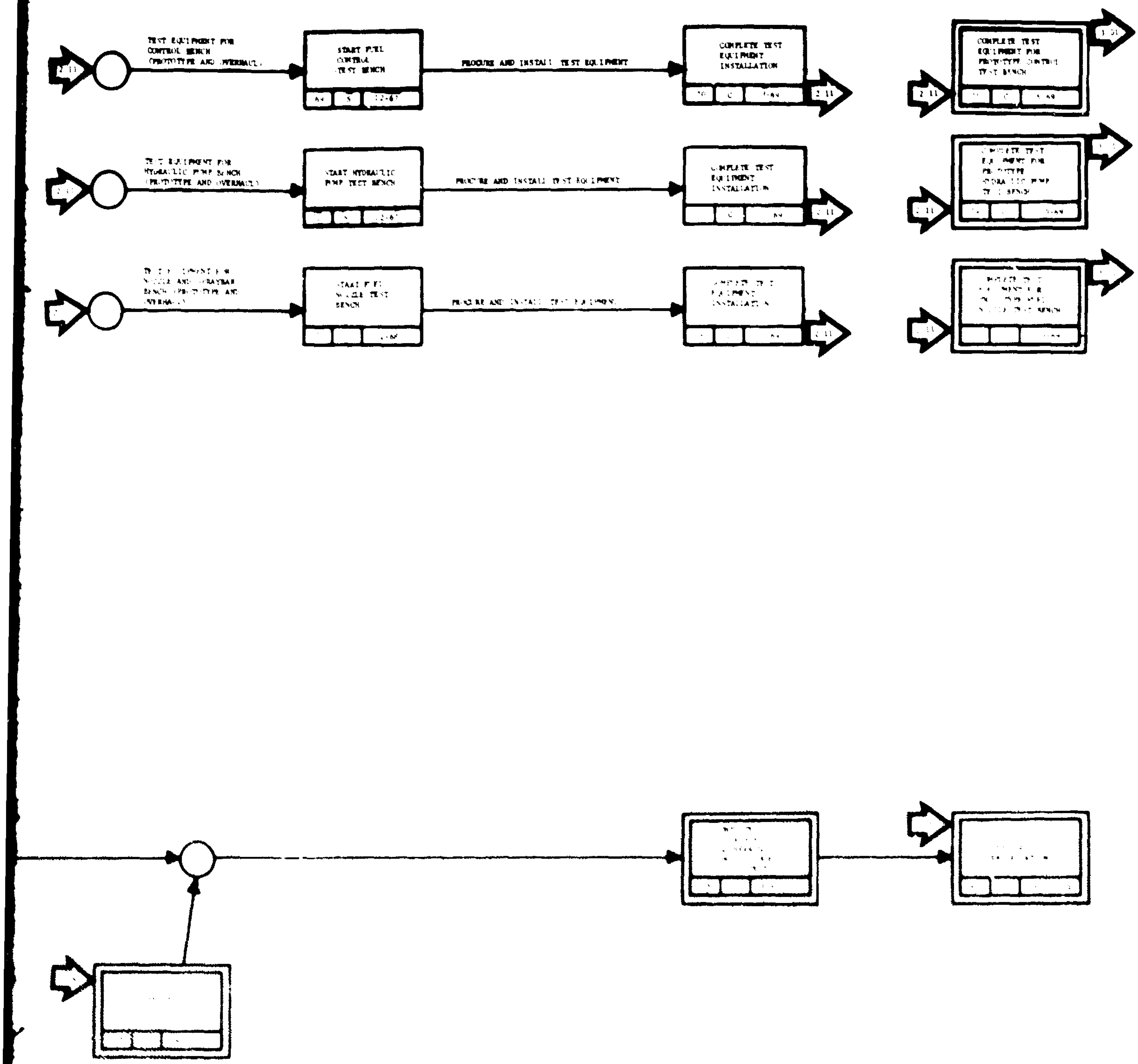


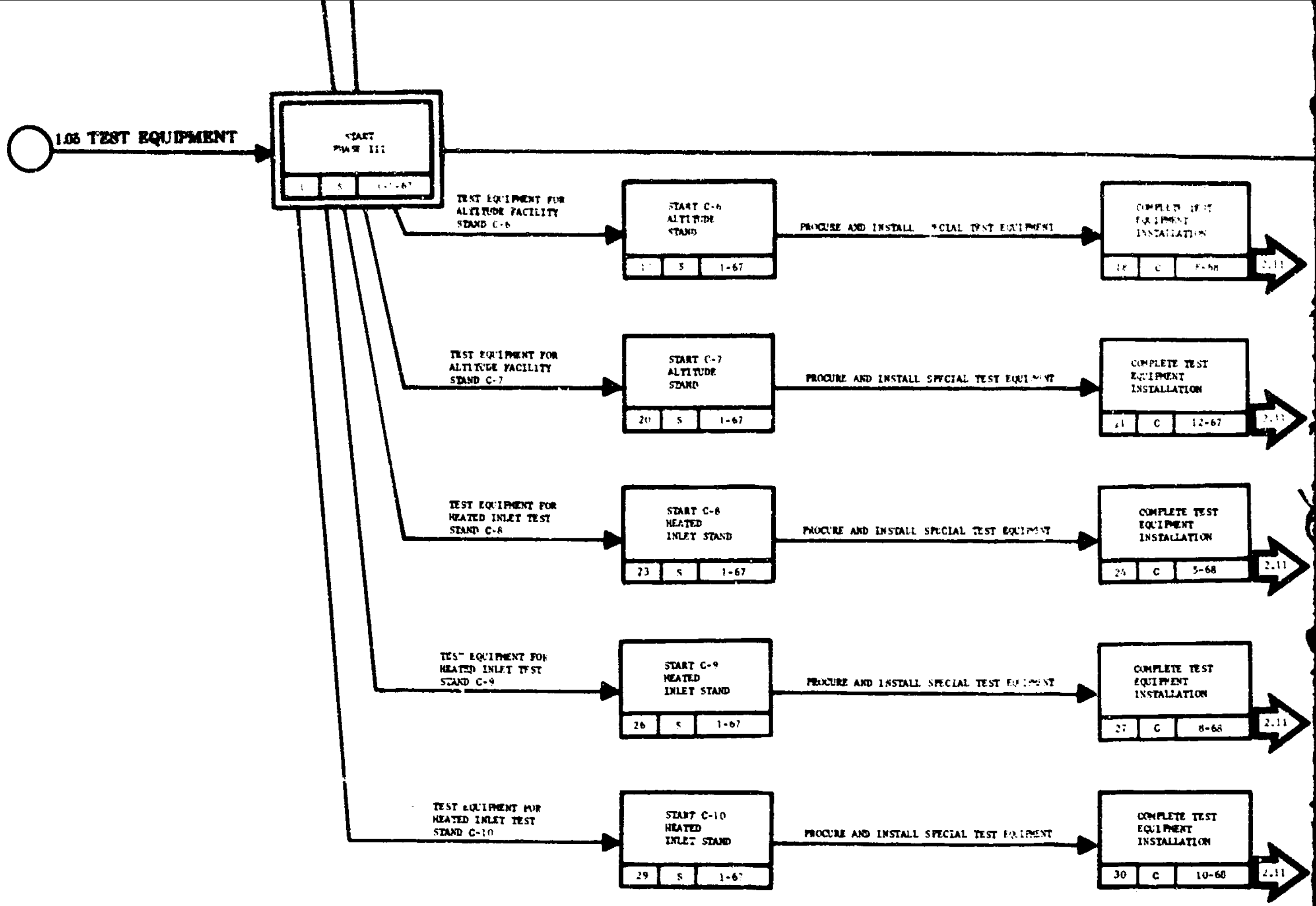
1.05
COMPLETE TEST EQUIPMENT INSTALLATION
C
9-67
2.11
COMPLETE TEST EQUIPMENT FOR A-5 STAND
4
C
10-67
COMPLETE TEST EQUIPMENT INSTALLATION
6
C
5-69
COMPLETE TEST EQUIPMENT FOR A-6 STAND
C
6-69
3.01
COMPLETE TEST EQUIPMENT INSTALLATION
9
C
7-69
COMPLETE TEST EQUIPMENT FOR A-7 STAND
10
C
COMPLETE TEST EQUIPMENT INSTALLATION
C
6-67
COMPLETE TEST EQUIPMENT FOR A-9 STAND
TEST EQUIPMENT FOR FUEL PUMP TEST BENCH

1.05 Test Equipment




2.11
TEST EQUIPMENT FOR CONTROL BENCH (PROTOTYPE AND OVERHAUL)
START FUEL CONTROL TEST BENCH
69
12-67
PROCURE AND INSTALL TEST EQUIPMENT
COMPLETE TEST EQUIPMENT INSTALLATION
2.11
2.11
TEST EQUIPMENT FOR HYDRAULIC PUMP BENCH (PROTOTYPE AND OVERHAUL)
START HYDRAULIC PUMP TEST BENCH
12-67
PROCURE AND INSTALL TEST EQUIPMENT
COMPLETE TEST EQUIPMENT INSTALLATION
NOZZLE AND SPRAYBAR BENCH (PROTOTYPE AND OVERHAUL)
START FUEL NOZZLE TEST BENCH
2-68
PROCURE AND INSTALL TEST EQUIPMENT
COMPLETE TEST EQUIPMENT INSTALLATION
2.11

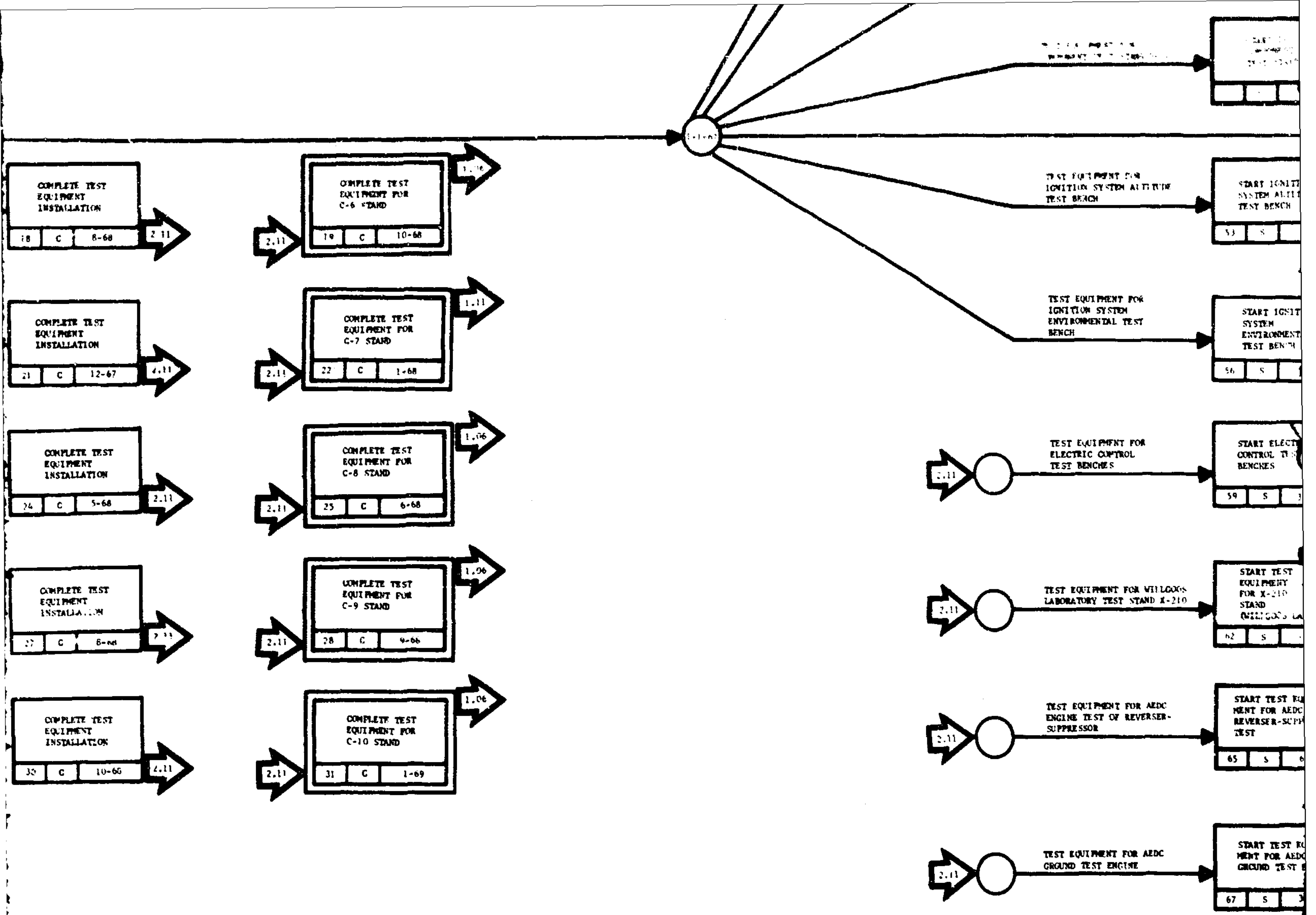

TEST EQUIPMENT FOR CONTROL BENCH (PROTOTYPE AND OVERHAUL)
START FUEL CONTROL TEST BENCH
PROCURE AND INSTALL TEST EQUIPMENT
COMPLETE TEST EQUIPMENT INSTALLATION
COMPLETE TEST EQUIPMENT FOR PROTOTYPE CONTROL TEST BENCH
START HYDRAULIC PUMP TEST BENCH
PROCURE AND INSTALL TEST EQUIPMENT
COMPLETE TEST EQUIPMENT INSTALLATION



Event Number	Description and Criteria
1	START PHASE III Start of Phase III Phase III go-ahead received from FAA.
2	START A-5 SEA LEVEL STAND Initiate design and procurement of the necessary special test equipment for A-5 sea level engine test stand. Design and procurement are in progress.
3	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on A-5 test stand. Test stand is ready for final checkout.
4	COMPLETE TEST EQUIPMENT FOR A-5 STAND Complete checkout of test equipment during final checkout of test stand. Operate engine.
5	START A-6 SEA LEVEL STAND Initiate design and procurement of the necessary special test equipment for A-6 sea level engine test stand. Design and procurement are in progress.
6	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on A-6 test stand. Test stand is ready for final checkout.
7	COMPLETE TEST EQUIPMENT FOR A-6 STAND Complete checkout of test equipment during final checkout of test stand. Operate engine.
8	START A-7 SEA LEVEL STAND Initiate design and procurement of the necessary special test equipment for A-7 sea level engine test stand Design and procurement are in progress.
9	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on A-7 test stand. Test stand is ready for final checkout.

Event Number	Description and Cri
10	COMPLETE TEST EQUIPMENT FOR A- Complete checkout of test equ checkout of test stand. Oper
11	START A-9 REVERSER STAND Initiate design and procureme special test equipment for A- test stand. Design and procu progress.
12	COMPLETE TEST EQUIPMENT INSTA Complete the installation of ment on A-9 test stand. Test final checkout.
13	COMPLETE TEST EQUIPMENT FOR A Complete checkout of test eq checkout of test stand. Oper
14	START C-4 ALTITUDE [illegible] Initiate design and procurem special test equipment for C- stand. Design and procuremen
15	COMPLETE TEST EQUIPMENT INSTA Complete the installation of ment on C-4 test stand. Test final checkout.
16	COMPLETE TEST EQUIPMENT FOR C Complete checkout of test equ checkout of test stand. Oper
17	START C-6 ALTITUDE STAND Initiate design and procurem special test equipment for C- Design and procurement are in
18	COMPLETE TEST EQUIPMENT INSTA Complete the installation of ment on C-6 test stand. Test for final checkout.
19	COMPLETE TEST EQUIPMENT FOR C Complete checkout of test eq checkout of test stand. Ope

Figure 10. 1.05 Test Equipment

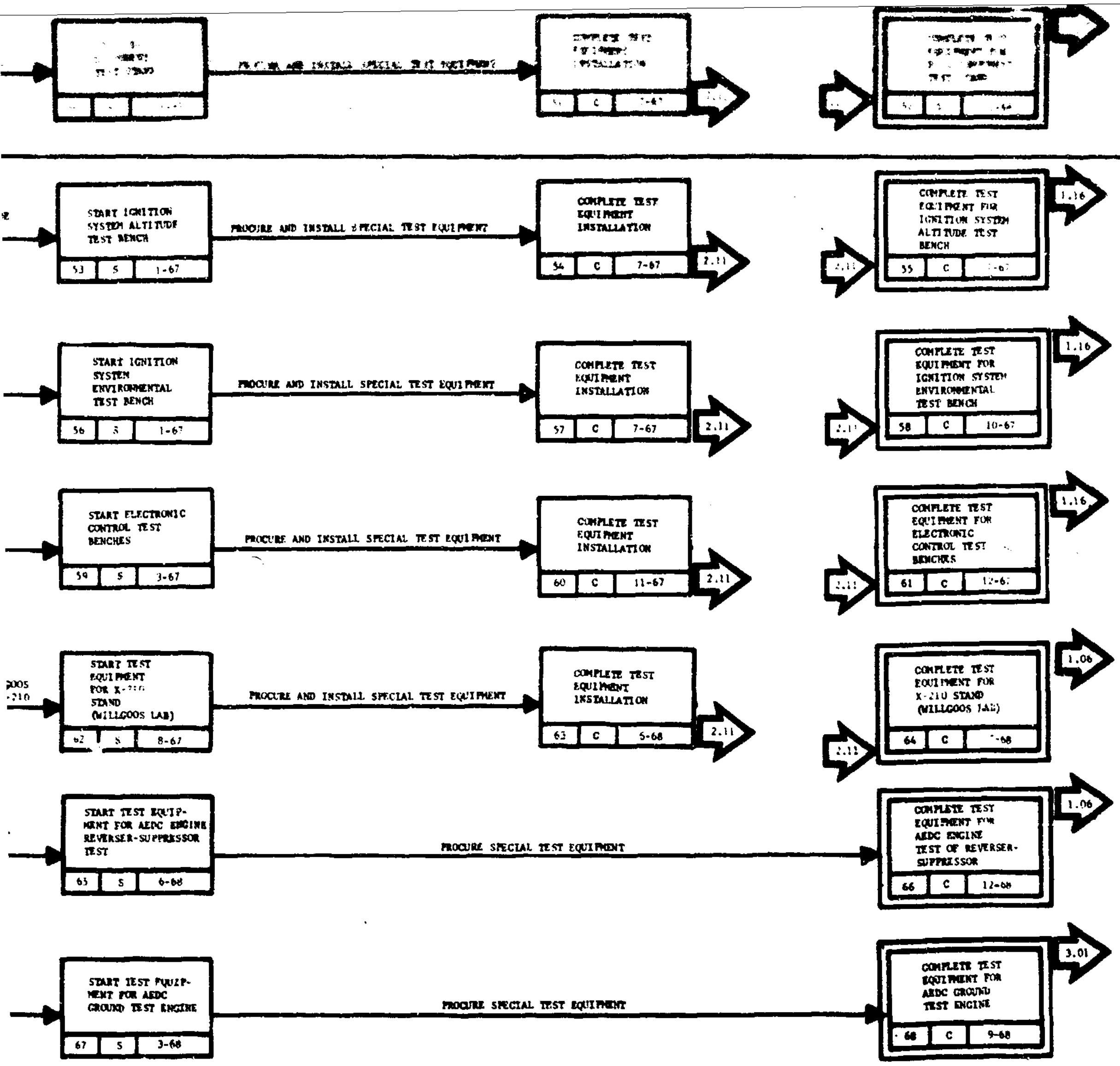


Description and Criteria
COMPLETE TEST EQUIPMENT FOR A-7 STAND Complete checkout of test equipment during final checkout of test stand. Operate engine.
START A-9 REVERSER STAND Initiate design and procurement of the necessary special test equipment for A-9 sea level engine test stand. Design and procurement are in progress.
COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on A-9 test stand. Test stand is ready for final checkout.
COMPLETE TEST EQUIPMENT FOR A-9 STAND Complete checkout of test equipment during final checkout of test stand. Operate engine.
START C-4 ALTITUDE STAND REMODIFICATION Initiate design and procurement of the necessary special test equipment for C-4 altitude test stand. Design and procurement are in progress.
COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on C-4 test stand. Test stand is ready for final checkout.
COMPLETE TEST EQUIPMENT FOR C-4 STAND Complete checkout of test equipment during final checkout of test stand. Operate engine.
START C-6 ALTITUDE STAND Initiate design and procurement of the necessary special test equipment for C-6 altitude test stand. Design and procurement are in progress.
COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on C-6 test stand. Test stand is ready for final checkout.
COMPLETE TEST EQUIPMENT FOR C-6 STAND Complete checkout of test equipment during final checkout of test stand. Operate engine.

Event Number	Description and Criteria
20	**START C-7 ALTITUDE STAND** Initiate design and procurement of the necessary special test equipment for C-7 altitude component test stand. Design and procurement are in progress.
21	**COMPLETE TEST EQUIPMENT INSTALLATION** Complete the installation of special test equipment on C-7 test stand. Test stand is ready for final checkout.
22	**COMPLETE TEST EQUIPMENT FOR C-7 STAND** Complete checkout of test equipment during final checkout of test stand. Operate engine.
23	**START C-8 HEATED INLET STAND** Initiate design and procurement of the necessary special test equipment for C-8 heated inlet test stand. Design and procurement are in progress.
24	**COMPLETE TEST EQUIPMENT INSTALLATION** Complete the installation of special test equipment on C-8 test stand. Test stand is ready for final checkout.
25	**COMPLETE TEST EQUIPMENT FOR C-8 STAND** Complete checkout of test equipment during final checkout of test stand. Operate engine.
26	**START C-9 HEATED INLET STAND** Initiate design and procurement of the necessary special test equipment for C-9 heated inlet test stand. Design and procurement are in progress.
27	**COMPLETE TEST EQUIPMENT INSTALLATION** Complete the installation of special test equipment on C-9 test stand. Test stand is ready for final checkout.
28	**COMPLETE TEST EQUIPMENT FOR C-9 STAND** Complete checkout of test equipment during final checkout of test stand. Operate engine.
29	**START C-10 HEATED INLET STAND** Initiate design and procurement of the necessary special test equipment for C-10 heated inlet test stand. Design and procurement are in progress.

Event Number	Description and Criteria
30	**COMPLETE TEST EQUIPMENT INSTALLATION** Complete the installation of special test equipment on C-10 test stand. Test stand is ready for final checkout.
31	**COMPLETE TEST EQUIPMENT FOR C-10 STAND** Complete checkout of test equipment during final checkout of test stand. Operate engine.
32	**START D-7 COMPONENT TEST BENCH** Initiate design and procurement of the necessary special test equipment for D-7 high temperature fuel bench. Design and procurement are in progress.
33	**COMPLETE TEST EQUIPMENT INSTALLATION** Complete the installation of special test equipment on D-7 high temperature fuel bench. Bench is ready for final checkout.
34	**COMPLETE TEST EQUIPMENT FOR D-7 COMPONENT TEST BENCH** Complete checkout of test equipment during final checkout of bench. Operate component.
35	**START D-10 COMPONENT TEST BENCH** Initiate design and procurement of the necessary special test equipment for D-10 fuel pump test bench. Design and procurement are in progress.
36	**COMPLETE TEST EQUIPMENT INSTALLATION** Complete the installation of special test equipment on D-10 fuel pump test bench. Bench is ready for final checkout.
37	**COMPLETE TEST EQUIPMENT FOR D-10 COMPONENT TEST BENCH** Complete checkout of test equipment during final checkout of bench. Operate fuel pump.
38	**START D-11 COMPONENT TEST BENCH** Initiate design and procurement of the necessary special test equipment for D-11 fuel control test bench. Design and procurement are in progress.
39	**COMPLETE TEST EQUIPMENT INSTALLATION** Complete the installation of special test equipment on D-11 fuel control test bench. Bench is ready for final checkout.

Event

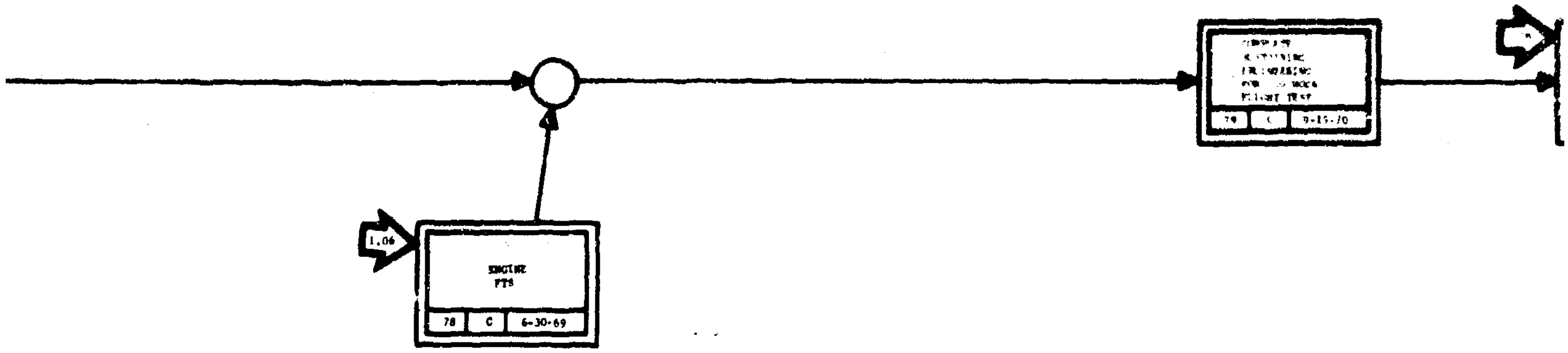


EVENT DICTIONARY
1.05 TEST EQUIPMENT

Event Number	Description and Criteria
40	COMPLETE TEST EQUIPMENT FOR D-11 COMPONENT TEST BENCH Complete checkout of test equipment during final checkout of test bench. Operate fuel control.
41	START D-12 COMPONENT STAND Initiate design and procurement of the necessary special test equipment for D-12 fuel control test bench. Design and procurement are in progress.
42	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on D-12 fuel control test bench. Bench is ready for final checkout.
43	COMPLETE TEST EQUIPMENT FOR D-12 COMPONENT STAND Complete checkout of test equipment during final checkout of test bench. Operate the fuel control.
44	START D-16 COMPONENT TEST BENCH Initiate design and procurement of the necessary special test equipment for D-16 hydraulic pump test bench. Design and procurement are in progress.
45	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on D-16 hydraulic pump test bench. Bench is ready for final checkout.
46	COMPLETE TEST EQUIPMENT FOR D-16 TEST BENCH Complete checkout of test equipment during final checkout of test bench. Operate the hydraulic pump.
47	START D-18 COMPONENT TEST BENCH Initiate design and procurement of the necessary special test equipment for D-18 fuel control test bench. Design and procurement are in progress.
48	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on D-18 fuel control test bench. Bench is ready for final checkout.

Event Number	Description and Criteria
49	COMPLETE TEST EQUIPMENT FOR D-18 TEST BENCH Complete checkout of test equipment during final checkout of test bench. Operate the fuel control.
50	START D-24 COMPONENT TEST STAND Initiate design and procurement of the necessary special test equipment for D-24 gearbox component test stand. Design and procurement are in progress.
51	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on D-24 component test stand. Test stand is ready for final checkout.
52	COMPLETE TEST EQUIPMENT FOR D-24 COMPONENT TEST STAND Complete checkout of test equipment during final checkout of test stand. Operate gearbox and lubrication system rig.
53	START IGNITION SYSTEM ALTITUDE TEST BENCH Initiate design and procurement of the necessary special test equipment for the ignition system altitude test bench. Design and procurement are in progress.
54	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on the ignition system altitude test bench. Bench is ready for final checkout.
55	COMPLETE TEST EQUIPMENT FOR IGNITION SYSTEM ALTITUDE TEST BENCH Complete checkout of test equipment during final checkout of test bench. Operate ignition system.
56	START IGNITION SYSTEM ENVIRONMENTAL TEST BENCH Initiate design and procurement of the necessary special test equipment for the ignition system environmental test bench. Design and procurement are in progress.

Event Number	Description
57	COMPLETE TEST EQUIPME Complete the installa equipment on the igni test bench. Bench is
58	COMPLETE TEST EQUIPME ENVIRONMENTAL TEST BE Complete checkout of checkout of test benc
59	START ELECTRONIC CONT Initiate design and p special test equipm control test benches. are in progress.
60	COMPLETE TEST EQUIPME Complete the installa equipment on the ele benches. Benches are
61	COMPLETE TEST EQUIPME TEST BENCHES Complete checkout of checkout of test benc fuel controls.
62	START TEST EQUIPMENT LABORATORY) Initiate design and p special test equipmen stand in the Willgoos procurement are in pr
63	COMPLETE TEST EQUIPME Complete the installa ment on X-210 altitud is ready for final ch
64	COMPLETE TEST EQUIPME LABORATORY) Complete checkout of checkout of test stan



Description and Criteria

COMPLETE TEST EQUIPMENT INSTALLATION
Complete the installation of special test equipment on the ignition system environmental test bench. Bench is ready for final checkout.

COMPLETE TEST EQUIPMENT FOR IGNITION SYSTEM ENVIRONMENTAL TEST BENCH
Complete checkout of test equipment during final checkout of test bench. Operate ignition system.

START ELECTRONIC CONTROL TEST BENCHES
Initiate design and procurement of the necessary special test equipment for two electronic fuel control test benches. Design and procurement are in progress.

COMPLETE TEST EQUIPMENT INSTALLATION
Complete the installation of special test equipment on the electronic control test benches. Benches are ready for final checkout.

COMPLETE TEST EQUIPMENT FOR ELECTRONIC CONTROL TEST BENCHES
Complete checkout of test equipment during final checkout of test benches. Operate electronic fuel controls.

START TEST EQUIPMENT FOR X-210 STAND (WILLGOOS LABORATORY)
Initiate design and procurement of the necessary special test equipment for X-210 altitude test stand in the Willgoos Laboratory. Design and procurement are in progress.

COMPLETE TEST EQUIPMENT INSTALLATION
Complete the installation of special test equipment on X-210 altitude test stand. Test stand is ready for final checkout.

COMPLETE TEST EQUIPMENT FOR X-210 STAND (WILLGOOS LABORATORY)
Complete checkout of test equipment during final checkout of test stand. Operate engine.

Event Number

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Description and Criteria

START TEST EQUIPMENT FOR AEDC ENGINE REVERSER-SUPPRESSOR TEST
Initiate design and procurement of the necessary special test equipment for the AEDC engine test of the reverser-suppressor. Design and procurement are in progress.

COMPLETE TEST EQUIPMENT FOR AEDC ENGINE TEST OF REVERSER-SUPPRESSOR
Complete procurement and inspection of the necessary test equipment required for the engine test of the reverser-suppressor at AEDC. Deliver test equipment with engine.

START TEST EQUIPMENT FOR AEDC GROUND TEST ENGINE
Initiate design and procurement of the necessary special test equipment for the first AEDC ground test engine. Design and procurement are in progress.

COMPLETE TEST EQUIPMENT FOR AEDC GROUND TEST ENGINE.
Complete procurement and inspection of the necessary test equipment required for the first AEDC ground test engine. Deliver test equipment with engine.

START FUEL CONTROL TEST BENCH
Initiate design and procurement of the necessary special test equipment for a prototype fuel control test bench. Design and procurement are in progress.

COMPLETE TEST EQUIPMENT INSTALLATION
Complete the installation of special test equipment on the prototype fuel control test bench. Bench is ready for final checkout.

COMPLETE TEST EQUIPMENT FOR PROTOTYPE CONTROL TEST BENCH
Complete checkout of test equipment during final checkout of test bench. Operate fuel control.

START HYDRAULIC PUMP TEST BENCH
Initiate design and procurement of the necessary special test equipment for a prototype hydraulic pump test bench. Design and procurement are in progress.

Event Number

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Description and Criteria

COMPLETE TEST EQUIPMENT INSTALLATION
Complete the installation of special test equipment on the prototype hydraulic pump test bench. Bench is ready for final checkout.

COMPLETE TEST EQUIPMENT FOR PROTOTYPE HYDRAULIC PUMP TEST BENCH
Complete checkout of test equipment during final checkout of test bench. Operate hydraulic pump.

START FUEL NOZZLE TEST BENCH
Initiate design and procurement of the necessary special test equipment for a prototype fuel nozzle test bench. Design and procurement are in progress.

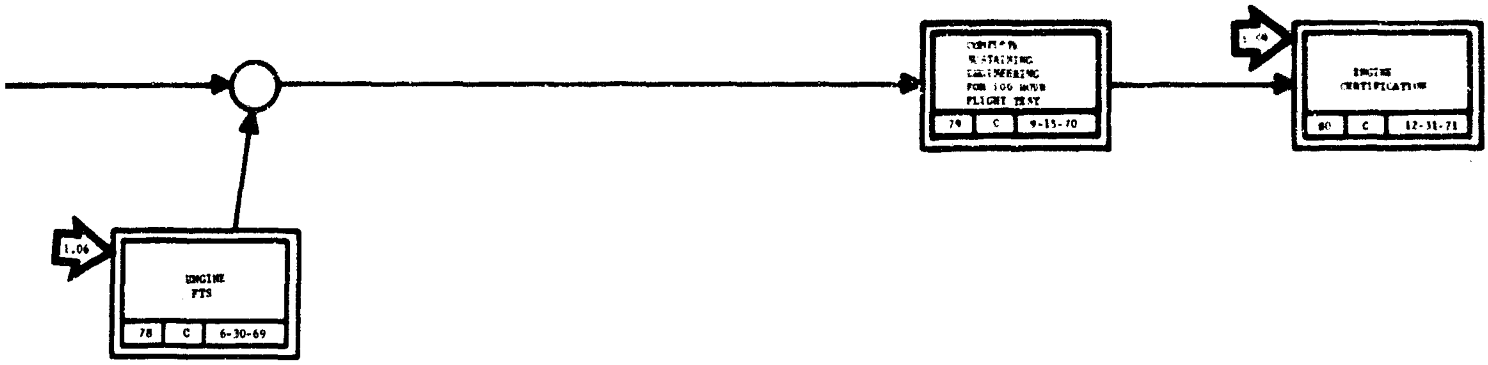
COMPLETE TEST EQUIPMENT INSTALLATION
Complete the installation of special test equipment on the prototype fuel nozzle test bench. Bench is ready for final checkout.

COMPLETE TEST EQUIPMENT FOR PROTOTYPE FUEL NOZZLE TEST BENCH
Complete checkout of test equipment during final checkout of test bench. Operate fuel nozzles.

ENGINE FTS
Reference engine network 1.06 for description and criteria.

COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST
End of Phase III. Completion of 100 hours of flight testing.

ENGINE CERTIFICATION
Reference engine network 1.06 for description and criteria.



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Event Number	Description and Criteria
65	START TEST EQUIPMENT FOR AEDC ENGINE REVERSER-SUPPRESSOR TEST Initiate design and procurement of the necessary special test equipment for the AEDC engine test of the reverser-suppressor. Design and procurement are in progress.
66	COMPLETE TEST EQUIPMENT FOR AEDC ENGINE TEST OF REVERSER-SUPPRESSOR Complete procurement and inspection of the necessary test equipment required for the engine test of the reverser-suppressor at AEDC. Deliver test equipment with engine.
67	START TEST EQUIPMENT FOR AEDC GROUND TEST ENGINE Initiate design and procurement of the necessary special test equipment for the first AEDC ground test engine. Design and procurement are in progress.
68	COMPLETE TEST EQUIPMENT FOR AEDC GROUND TEST ENGINE. Complete procurement and inspection of the necessary test equipment required for the first AEDC ground test engine. Deliver test equipment with engine.
69	START FUEL CONTROL TEST BENCH Initiate design and procurement of the necessary special test equipment for a prototype fuel control test bench. Design and procurement are in progress.
70	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on the prototype fuel control test bench. Bench is ready for final checkout.
71	COMPLETE TEST EQUIPMENT FOR PROTOTYPE CONTROL TEST BENCH Complete checkout of test equipment during final checkout of test bench. Operate fuel control.
72	START HYDRAULIC PUMP TEST BENCH Initiate design and procurement of the necessary special test equipment for a prototype hydraulic pump test bench. Design and procurement are in progress.

Event Number	Description and Criteria
73	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on the prototype hydraulic pump test bench. Bench is ready for final checkout.
74	COMPLETE TEST EQUIPMENT FOR PROTOTYPE HYDRAULIC PUMP TEST BENCH Complete checkout of test equipment during final checkout of test bench. Operate hydraulic pump.
75	START FUEL NOZZLE TEST BENCH Initiate design and procurement of the necessary special test equipment for a prototype fuel nozzle test bench. Design and procurement are in progress.
76	COMPLETE TEST EQUIPMENT INSTALLATION Complete the installation of special test equipment on the prototype fuel nozzle test ch. Bench is ready for final checkout.
77	COMPLETE TEST EQUIPMENT FOR PROTOTYPE FUEL NOZZLE TEST BENCH Complete checkout of test equipment during final checkout of test bench. Operate fuel nozzles.
78	ENGINE FTS Reference engine network 1.06 for description and criteria.
79	COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST End of Phase III. Completion of 100 hours of flight testing.
80	ENGINE CERTIFICATION Reference engine network 1.06 for description and criteria.

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1.06 ENGINE TEST - GROUND

The JTF17 engine will be developed to meet all the requirements of the engine model specification, recognizing the FAA's objective of obtaining a 600-hour minimum TBO for initial aircraft service with escalation of this overhaul interval to at least 3000 hours. It is the intent of the engine development program first, to demonstrate the specification performance levels; and second, by means of limits, overstress and endurance tests, to ferret out engine weaknesses and to force the appearance of failures during the ground test development cycle prior to the flight program.

This engineering development test program is designed to obtain the maximum amount of meaningful information in the shortest possible time. Design changes dictated by test results can thus be translated quickly into hardware, improvements can be verified by further testing, and product maturity can be achieved in minimum time.

The test goal for the development of the JTF17 engine in Phase III is the completion of the Flight Test Status Test in June 1969, and in Phase IV the completion of the Engine Certification Test in December 1971. Toward these goals it is ancitipated that the following approximate hours of engine and component rig test time will have been accumulated:

	Hours at FTS	Hours at End of Phase III	Hours at Engine Certification
Engine	4,000	8,000	14,500
Fan and Compressor	2,920	4,300	5,500
Primary Combustor	4,700	6,900	9,250
Turbine	2,540	3,290	3,750
Augmentor	2,460	3,220	3,970
Exhaust System	3,150	4,600	6,150
Controls and Accessories	46,000	90,000	137,000
Lubricants, Lubrication System, Bearings, Seals, and Gears	41,150	54,500	58,450

Statistical methods will be applied during the pretest planning to assist in the test integration. Component and engine test programs are devised to obtain the maximum relevant information from each test by (1) proper design of experiments, (2) analysis of instrumentation precision and accuracy, (3) statistical data analysis, and (4) the measurement of the uncertainty associated with the estimates and conclusions based on experimental data. Statistical methods will also be used in optimizing computer data reduction programs, determining instrumentation requirements and calibration methods, and in the analysis of reliability data.

Initial engine testing in Phase III will be conducted utilizing the three JTF17A-20 engines available from Phase II-C. These engines will be supplemented by additional development engines that have been fabricated to the JTF17 parts list resulting from the Phase II-C effort. The three engines completed in Phase II-C will be refurbished to the later design during Phase III. Approximately 12 JTF17 development engines will be active in the program through engine FTS and 15 engines through Certification. It is expected that approximately 4000 hours will have been accumulated by FTS and 14,500 hours by Engine Certification.

The component and engine test programs are closely interrelated. It is the purpose of the engine test program to continue the development of the components as an integrated part of the engine systems. Complete component interaction cannot be adequately simulated in the component test rigs.

Engine testing will be conducted at sea level conditions with and without heated inlet and also at simulated altitude conditions.

A. Engine Calibration

1. Sea Level Calibration

Sea level calibrations will be accomplished to determine engine and component performance. Pertinent parameters will be recorded to measure the integrated system performance; i.e., airflow, fuel flow, thrust, inlet and discharge pressure and temperature of the fan and high compressor, main burner pressure drop, turbine discharge pressure and temperature, duct heater inlet and discharge pressure and temperature, and reverser-suppressor discharge pressure and temperature. Calibrations will be completed with and without the reverser-suppressor installed on the engine.

Design modifications will be accomplished as dictated by test results. These modifications will be incorporated into the engine and additional calibrations will be completed.

2. Altitude Calibrations

Altitude calibrations to determine performance will be conducted under simulated transonic, subsonic, and cruise conditions except as limited by the facilities utilized. The same types of parameters as described in (1) preceding, will be recorded. As in the case of the sea level calibrations, design changes in the engine will be evaluated where they affect performance.

3. Types of Calibrations

a. Starting

Sea level starting calibrations will be accomplished to establish and develop the engine start cycle. Such variables as ignition, speed fuel flow, etc., will be measured.

b. Windmill

The engine windmill airflow will be measured over a range of altitude and Mach numbers to determine windmilling drag.

c. Altitude Relight

Primary combustor and duct heater relight capability will be developed to meet the requirements of the engine model specification, and the relight margin will be established.

d. Performance

Sea level and altitude calibrations will be accomplished to establish and develop the required level of performance of the complete engine as well as component interrelated performance.

B. Reliability and Durability

1. Endurance

An intensive endurance program which includes limits and weak link testing to uncover engine deficiencies will be completed under both sea level and altitude conditions to develop and establish the durability and reliability of the JTF17 engine system and the reverser-suppressor. The initial phase of this program will be accomplished at sea level conditions and, as soon as adequate capability has been demonstrated, the program will be extended to the altitude phase to test the engine at subsonic, transonic, and cruise conditions. A major portion of this testing will be conducted in the form of a typical mission cycle, as defined by the engine model specification.

2. Vibration and Stress

Sea level and altitude engine tests will be accomplished to measure and reduce to acceptable levels the operational engine system vibration and stress levels of all major rotating and stationary components such as blades, disks, shafts, front and rear engine mounts, compressor and turbine stators, etc., during steady-state and transient sea level, subsonic, transonic, and cruise conditions. Critical speed calculations will be verified by this testing and monitoring points for future Aircraft Integrated Data Systems will be established, in part, by this testing through the establishment and monitoring of linear vibration pickup points.

3. Heat Rejection

Engine fuel and oil system heat rejection characteristics will be established and developed to the level required for satisfactory engine operation. This development will be conducted at both sea level and altitude and at all engine operating conditions. In addition, engine case heat rejection levels will be established for conditions through the engine operating envelope.

4. Ingestion Tests

Ice and birds will be introduced into the engine inlet with the engine operating at various engine power settings and at various subsonic speeds.

5. Fatigue Life Tests

a. Low Cycle Fatigue (LCF)

Engine cyclic testing will be conducted to supplement laboratory material and spin pit tests to develop and demonstrate adequate LCF of all compressor and turbine disks. Each LCF test cycle will consist of a simulated climb to cruise Mach number from sea level takeoff and return. Cycling will be conducted at the rate of temperature changes anticipated for aircraft service. These cycles will be accomplished in a sea level test stand utilizing heated inlet air. Intermediate inspections will be made to record pertinent data such as disk and blade growth and parts distortion.

b. Thermal Fatigue

The development of adequate thermal fatigue life capability will be accomplished through cyclic engine tests consisting of accelerations from idle conditions to maximum turbine inlet temperature and return. It is the goal of this program to demonstrate total system integrity for 1000 cycles.

6. Thermal Gradient Tests

These tests will be conducted at both sea level and altitude conditions to obtain steady-state and transient temperature data of critical rotating and stationary parts to develop and demonstrate satisfactory thermal gradients. Of particular interest are bore to rim disk, and turbine blade and vane radial and chordwise gradient characteristics.

7. Noise Level

Calibrations of the complete engine with the reverser-suppressor installed will be obtained to establish the perceived noise levels at various engine power settings up to sea level takeoff conditions. Measurements will be made of both near and far field noise. Analysis will be made of the data from these tests, and design modifications will be accomplished and evaluated. Variations of the quantity of secondary and tertiary air supplied to the reverser-suppressor are typical of some of the modifications that may be tested. Duct sound attenuation schemes such as acoustic liners, will also be investigated, if required.

8. Containment

During the course of engine testing at overspeed, overtemperature, and high vibratory and stress level conditions some failures of engine parts will undoubtedly occur and the ability of the engine to contain such failures will be demonstrated. In addition to engine testing, failures

that occur in compressor and turbine rigs will also serve to demonstrate the ability of the engine to contain such failures. It is to be noted that these component test rigs utilize engine-type cases or the equivalent.

9. Failure Analysis

Engine testing at overload conditions will force failures of engine parts to occur. These failures will be analyzed and corrective action will be taken. Retesting of the redesigned components under those conditions which induced the original failure will be conducted to establish the validity of the corrective action. This work will be supplemented by laboratory testing of engine materials and structural parts under simulated loads. Stress coating and strain gages will be used in this test effort.

10. Simulated Flight Maneuver Loads

Static frame testing under simulated manuever load conditions will be conducted on all major structural cases. These tests are accomplished by applying the loads encountered under flight maneuver conditions to a static frame consisting of the engine structural load carrying cases. Stress-coat material will be used to define the high stress areas, and the subsequent reapplication of the simulated flight maneuver loads with the strain gages located at the high stress areas will enable accurate determination of the stress level of the part. Corrective redesign action will be taken, as required, and the parts will be subsequently retested.

11. High "Q" Test

Engine tests will be conducted at engine operating conditions simulating the range of high "Q" conditions to be encountered in service use to demonstrate the engine structural reliability. These tests will also serve to further demonstrate the durability and reliability of the thrust bearings.

12. Control System

Engine tests directed toward development of the control system will be conducted at both sea level and altitude conditions. These tests will include evaluation and development at transient as well as steady-state operation of items such as throttle response, main and duct heater fuel flow metering, duct heater nozzle response rate, etc. Integrated engine system development of each of the control systems will be accomplished. This will include evaluation of the main fuel control, duct heater controls, bleed pilot valves, hydraulic system, etc.

13. Integrated Engine System Component Tests

The component test program includes performance and durability development at sea level and altitude conditions. Off-design and limits testing will be accomplished to determine component operation margins. These data will be used to assist the design effort involving corrective action or redesign and the establishment of service operation limits. In addition, the component programs will evaluate the effectiveness of service repair techniques and service repair limits. Extensive instrumentation will be used as required in the component rigs for the aforementioned programs.

a. Fan and High Compressor

Engine testing at sea level and altitude steady-state and transient and at starting conditions will be conducted to determine and develop satisfactory operation of the fan and high compressor with respect to the following:

1. Stress levels
2. Performance
3. Surge characteristics
4. Distortion tolerance
5. Flow split (duct flow vs high compressor flow)
6. Durability
7. Service repair limits.

b. Main Burner Test

Sea level and altitude tests will be conducted at transient and steady-state conditions to determine and develop satisfactory main burner performance characteristics in the following areas:

1. Pressure loss
2. Turbine inlet temperature pattern, radial and circumferential
3. Durability
4. Service limits
5. Repair limits
6. Fuel nozzle performance (carbon formation, correct spray pattern, etc.)
7. Relight capability.

c. Turbine Test

Engine testing will be conducted at sea level and altitude conditions under both steady-state and transient conditions to develop satisfactory operation of the turbine with respect to the following:

1. Performance
2. Durability of materials and coatings
3. Cooling effectiveness of aircooled stages
4. Thermal fatigue life
5. Overtemperature.

d. Duct Heater Test

Sea level and altitude tests will be accomplished at steady-state and transient conditions directed toward the satisfactory development of the following characteristics of the duct heater:

1. Durability and reliability
2. Performance
3. Relight capabilities and characteristics
4. Nozzle response rate
5. Radial and circumferential temperature distribution.

e. Reverser-Suppressor Test

Engine testing will be conducted to develop the required capability of the reverser-suppressor with respect to the following:

1. Performance
2. Durability
3. Noise suppression
4. Reverse thrust capability.

14. Maintainability

The total maintainability concept designed into the engine will be demonstrated in the engine test program. Specific items that will be established are:

1. The number of manhours to perform operations such as filter inspection, fuel control component replacement, hot section inspection, main burner liner inspection, duct heater inspection, high compressor inspection, reverser-suppressor removal, 1st-stage turbine vane replacement, and turbine replacement
2. Adequacy of the tools to accomplish the above mentioned tasks
3. Adequacy of techniques such as radioisotope and X-ray, for inspection of internal engine parts
4. Adequacy of the locations of inspection ports, borescope holes, tube connections, brackets, ground handling lugs, etc., to facilitate maintainability.

15. Flight Test Status Test (FTS)

The suitability of the engine for use in the prototype flight program will be demonstrated by the satisfactory completion of an FTS in June 1969, in accordance with the requirements of the 75-hour endurance test described in the JTF17 engine model specification. The official FTS test will be preceded by at least one unofficial endurance test to this schedule.

16. Engine Certification Test

During Phase IV the official engine certification test, in accordance with the schedule defined by the engine model specification, will be completed on December 1, 1971. The official test will be preceded by at least one unofficial test. This test and the supporting data for certification will encompass the following:

1. 150-hour endurance test at simulated aircraft mission conditions
2. Maximum low and high rotor speed test
3. Starting
4. Maximum exhaust gas temperature tests
5. Maximum oil temperature tests
6. Engine component bench and environment tests
7. Oil tank tests
8. Foreign object ingestion
9. Demonstration of LCF characteristics
10. Surge characteristics
11. Fuel system icing tests
12. Induction system icing tests
13. Failure analysis of control system
14. Turbine rotor overspeed test and measurement of disk and blade stress in engine and/or rigs
15. Turbine overtemperature test and measurement of disk and blade stress in engine and/or rigs
16. Thrust response
17. Gearbox substantiation - 150-hour endurance test at rated torque
18. Calibrations - performance demonstrated before and after the endurance test.

The major milestones, network chart and event dictionary for engine testing are shown in figures 11 and 12, respectively.

A detailed description of the engine test program is presented in the Test and Certification Plan, Volume III, Report E, and testing planning and integration is presented in Test, Volume IV, Report E.

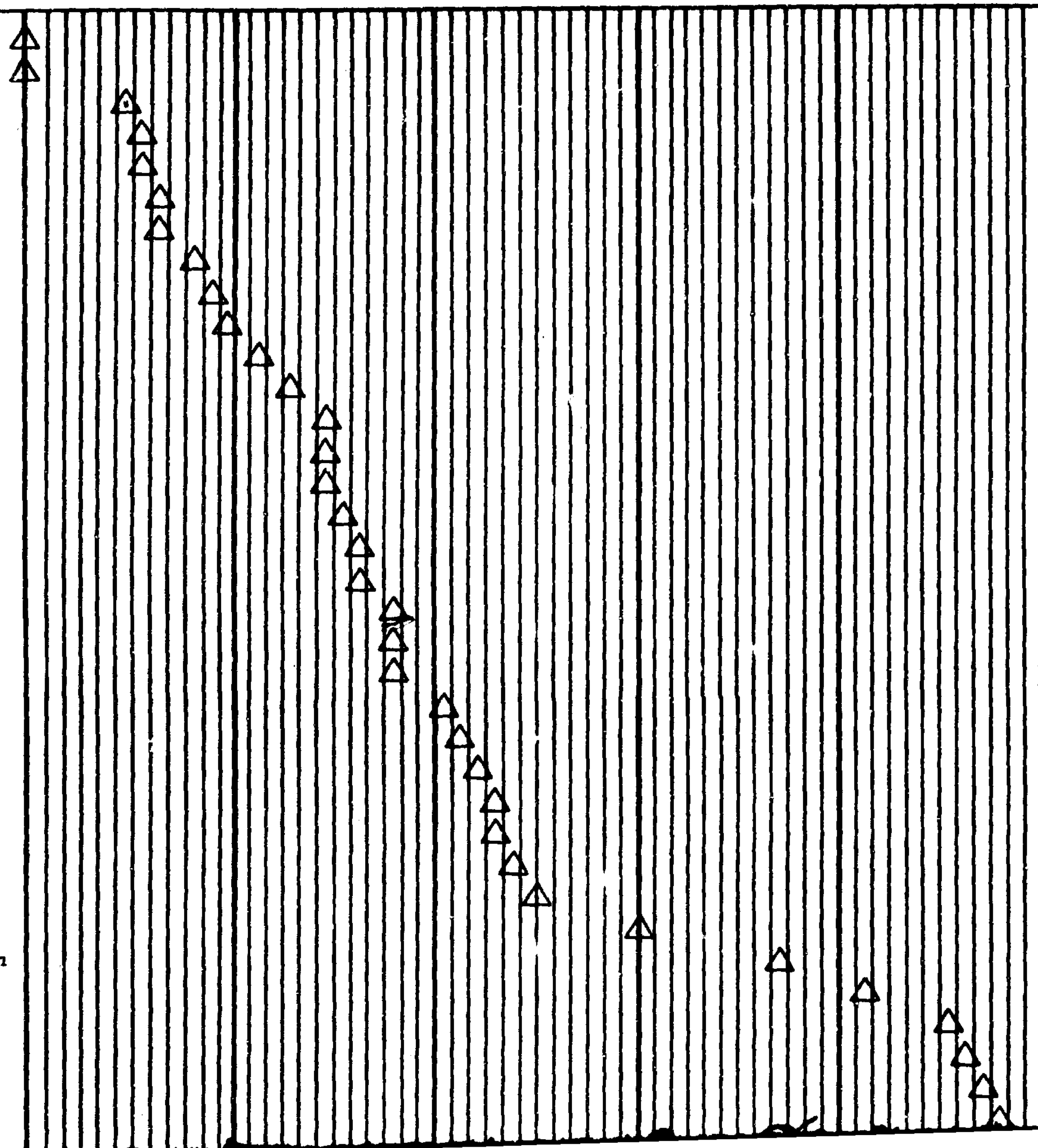
1.06 ENGINE DEVELOPMENT SCHEDULE

FACILITIES

1. ALTITUDE FACILITY STANDS - C-4 AND C-6
2. SEA LEVEL TEST STANDS - A-3, A-4, AND A-5
3. HEATED INLET TEST STANDS - C-8, C-9, AND C-10
4. SEA LEVEL REVERSER TEST STAND A-9
5. WILLGOOS LABORATORY TEST STAND X-210

MILESTONES

START PHASE III
CONTINUE PHASE II-C ENGINE TESTING
START TESTS OF FOURTH DEVELOPMENT ENGINE
START TESTS OF FIFTH DEVELOPMENT ENGINE
START EXHAUST SYSTEM PERFORMANCE TESTS
START SEA LEVEL ENDURANCE TESTS
START TESTS OF SIXTH DEVELOPMENT ENGINE
START TESTS OF FIRST REFURBISHED DEVELOPMENT ENGINE
START INLET DISTORTION TESTS
START TESTS OF SECOND REFURBISHED DEVELOPMENT ENGINE
START TESTS OF THIRD REFURBISHED DEVELOPMENT ENGINE
START TESTS OF SEVENTH DEVELOPMENT ENGINE
START CRUISE ENDURANCE TESTS
START SIMULATED INLET TEST
START INTEGRATED CONTROL SYSTEM TESTS
START TESTS OF EIGHTH DEVELOPMENT ENGINE
START TESTS AT SUBSONIC CONDITIONS
START ALTITUDE RELIGHT TESTS
START FTS SUPPORTING DURABILITY TESTS
START TESTS OF NINTH DEVELOPMENT ENGINE
START AEDC ENGINE TESTS
START TESTS OF TENTH DEVELOPMENT ENGINE
START AEDC ENGINE PERFORMANCE TEST OF EXHAUST SYSTEM
START FTS PERFORMANCE TEST
UNOFFICIAL FTS TEST
START TESTS OF ELEVENTH DEVELOPMENT ENGINE
START TESTS OF TWELFTH DEVELOPMENT ENGINE
ENGINE FTS
FIRST SCHEDULED FLIGHT TEST
COMPLETE SUSTAINING ENGINEERING FOR 100-HR FLIGHT TEST
START CERTIFICATION SUPPORTING DURABILITY TESTS
START TESTS OF THIRTEENTH DEVELOPMENT ENGINE
START CERTIFICATION PERFORMANCE TEST
START TESTS OF FOURTEENTH DEVELOPMENT ENGINE
START TESTS OF FIFTEENTH DEVELOPMENT ENGINE
UNOFFICIAL CERTIFICATION TEST



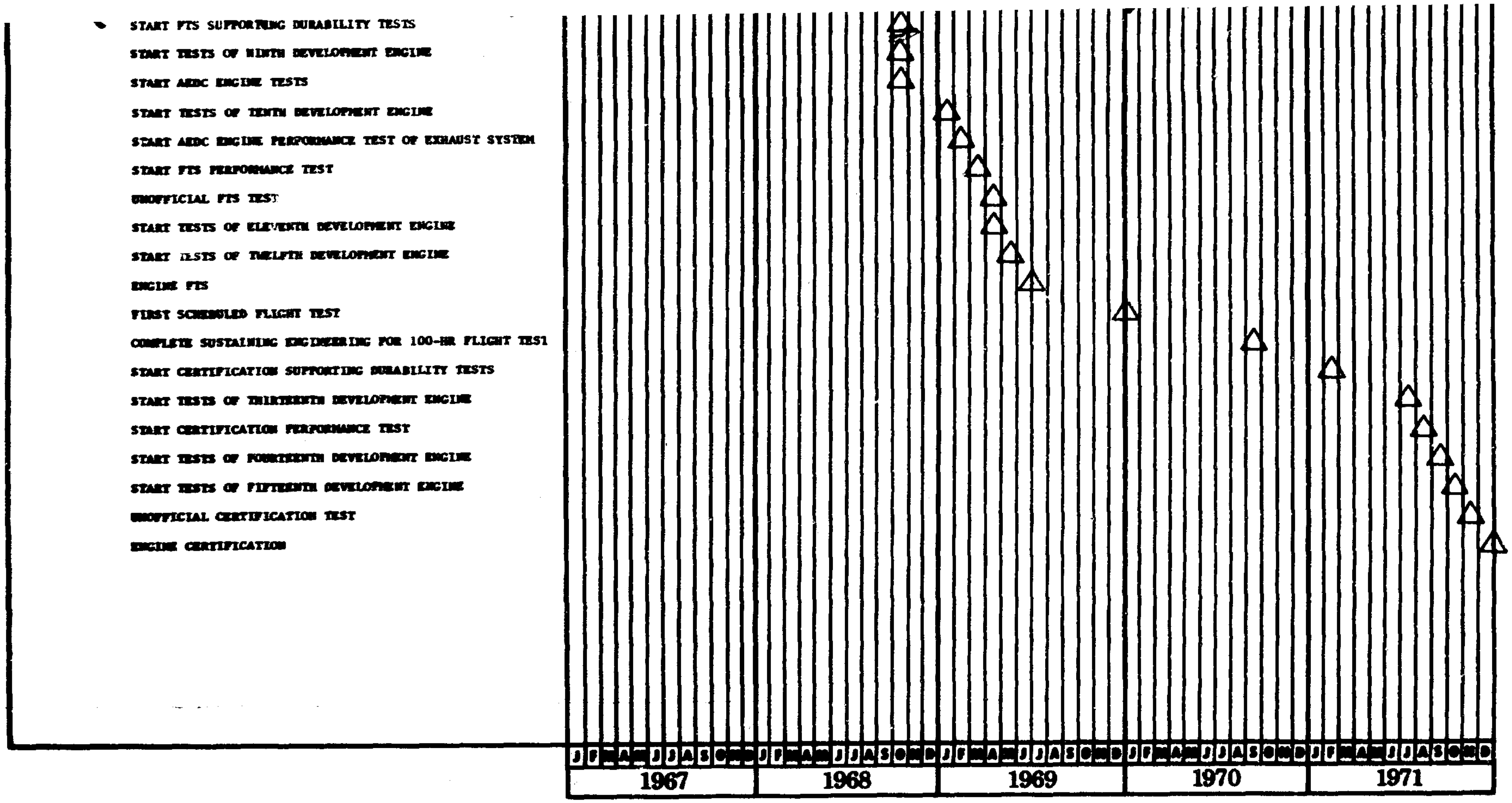


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Figure 11. 1.06 Engine Test - Ground

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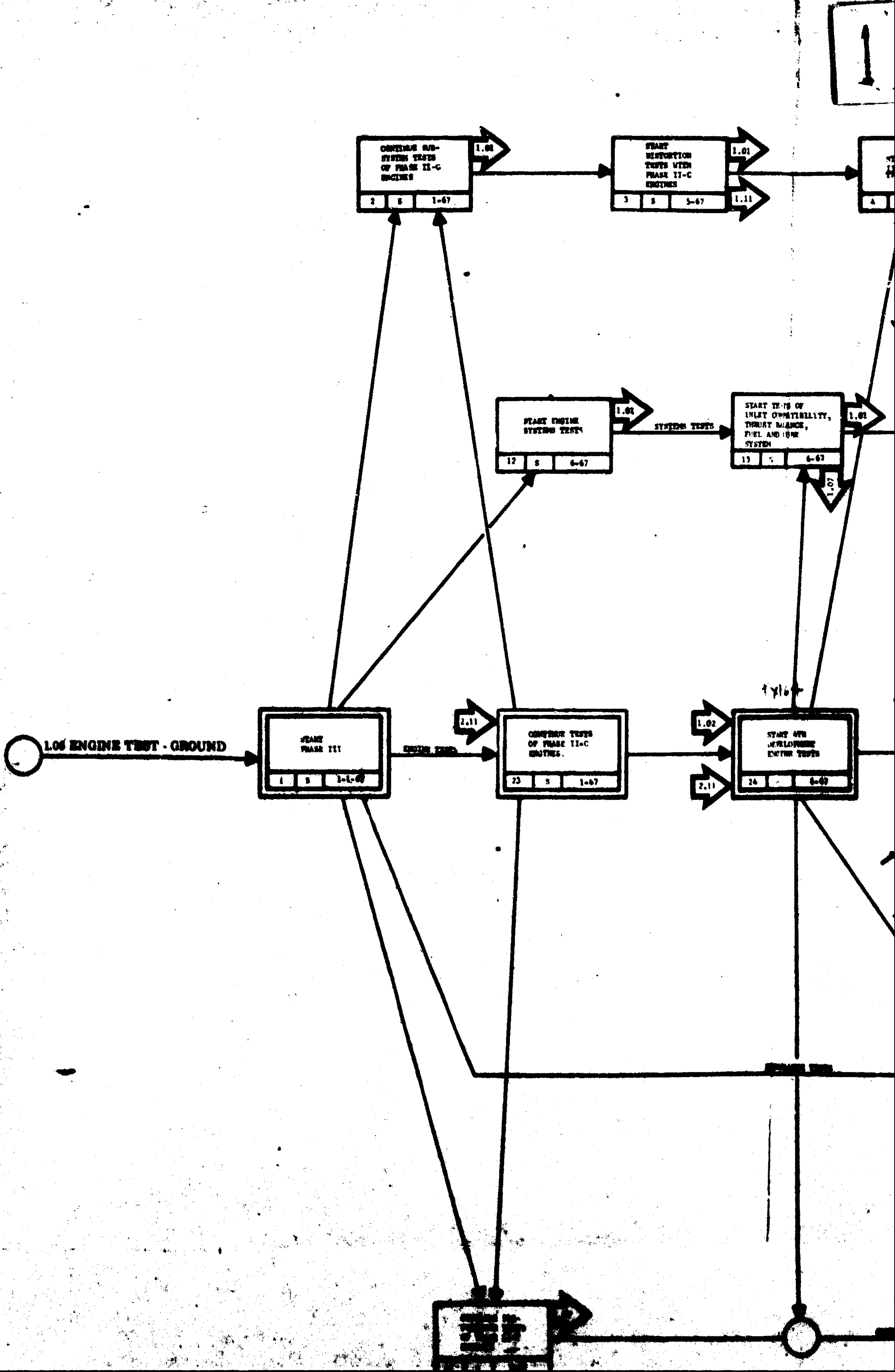

1.06 ENGINE TEST - GROUND
START PHASE III
CONTINUE TESTS OF PHASE II-C ENGINES.
START 4TH DEVELOPMENT ENGINE TESTS
START ENGINE SYSTEMS TESTS
SYSTEMS TESTS
ENGINE TESTS
START DISTORTION TESTS WITH PHASE II-C ENGINES
CONTINUE SUB-SYSTEM TESTS OF PHASE II-C ENGINES
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1.11
1.02
1.07
2.11

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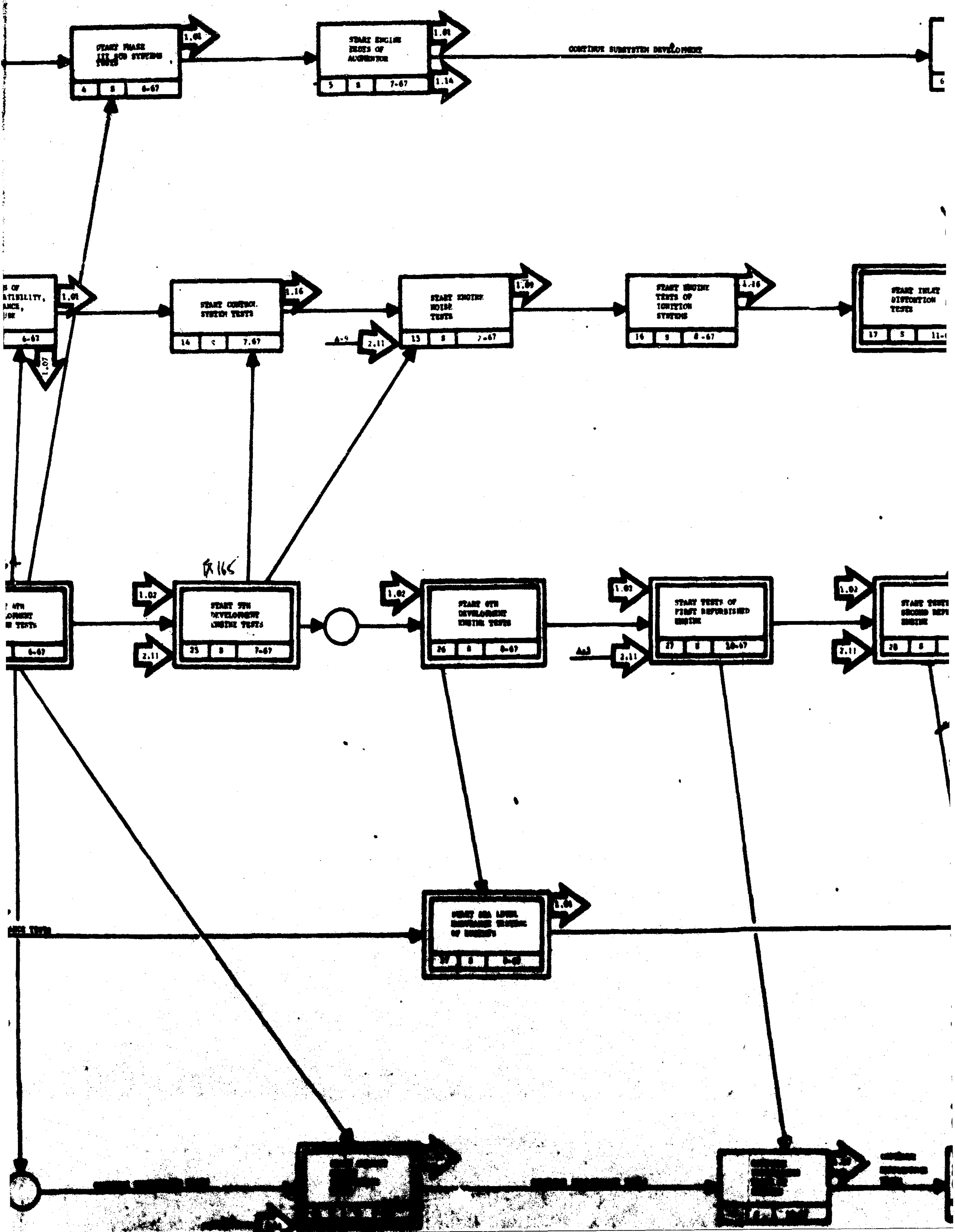

START PHASE III ECU SYSTEMS TESTS
1.01
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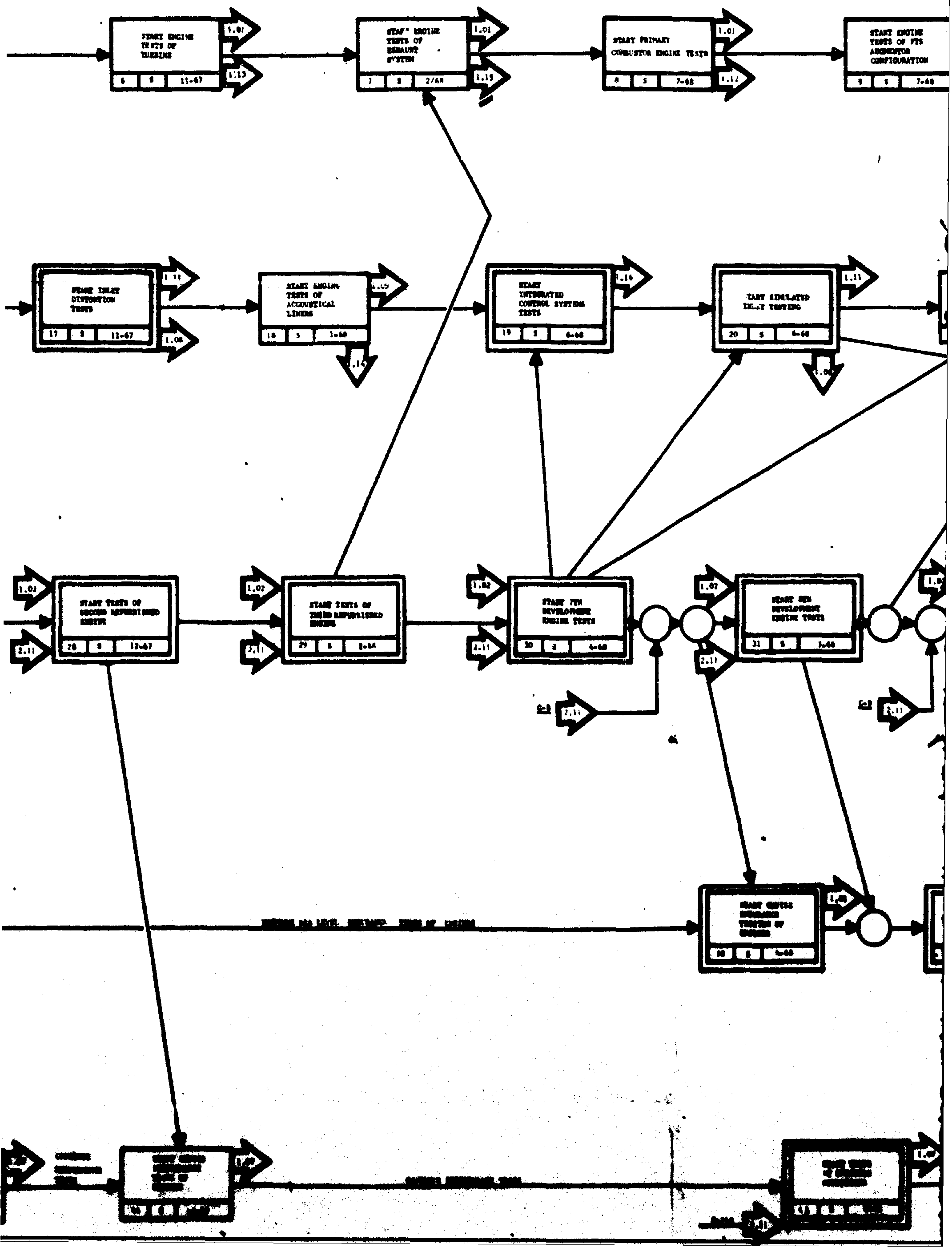
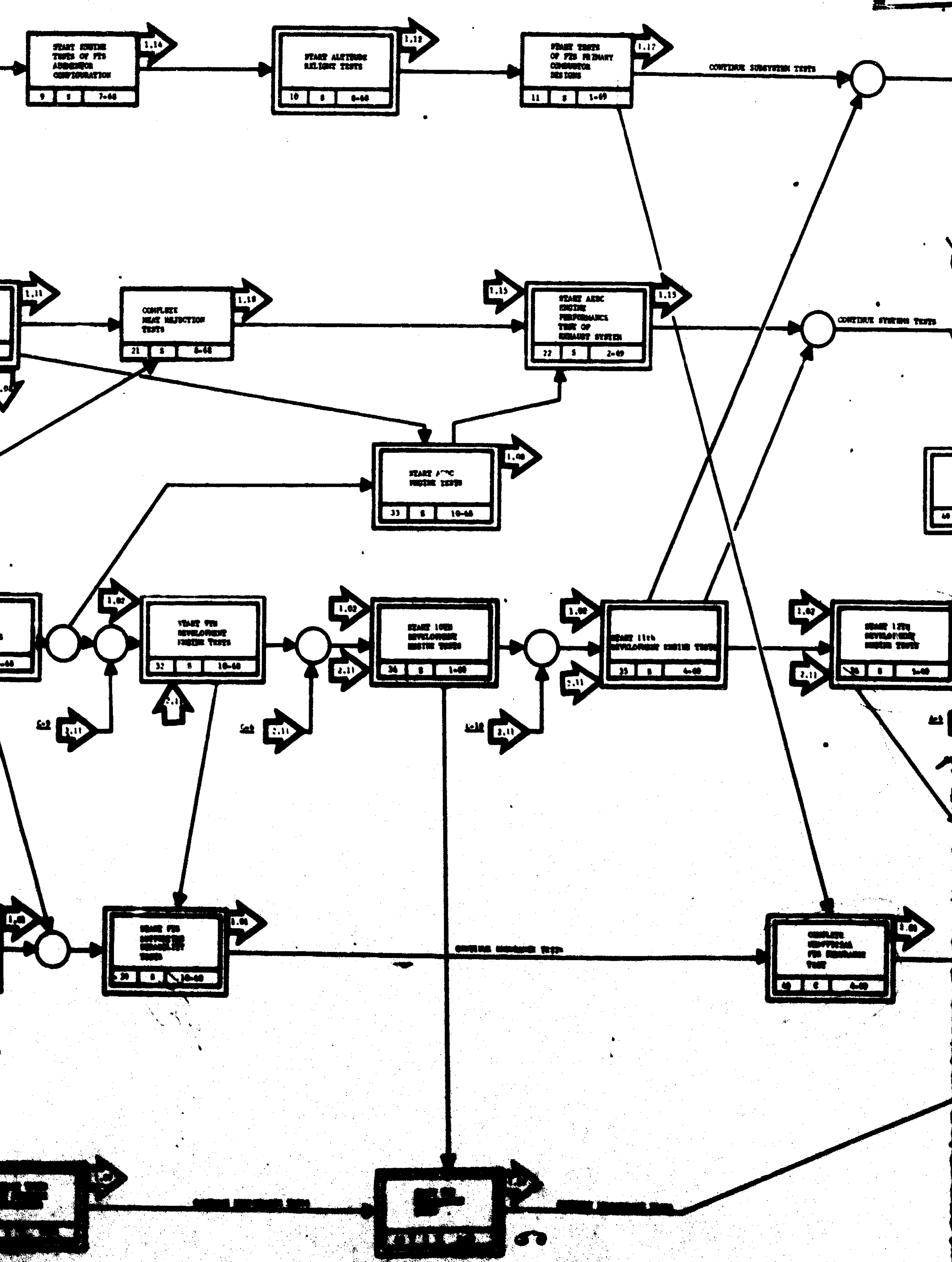
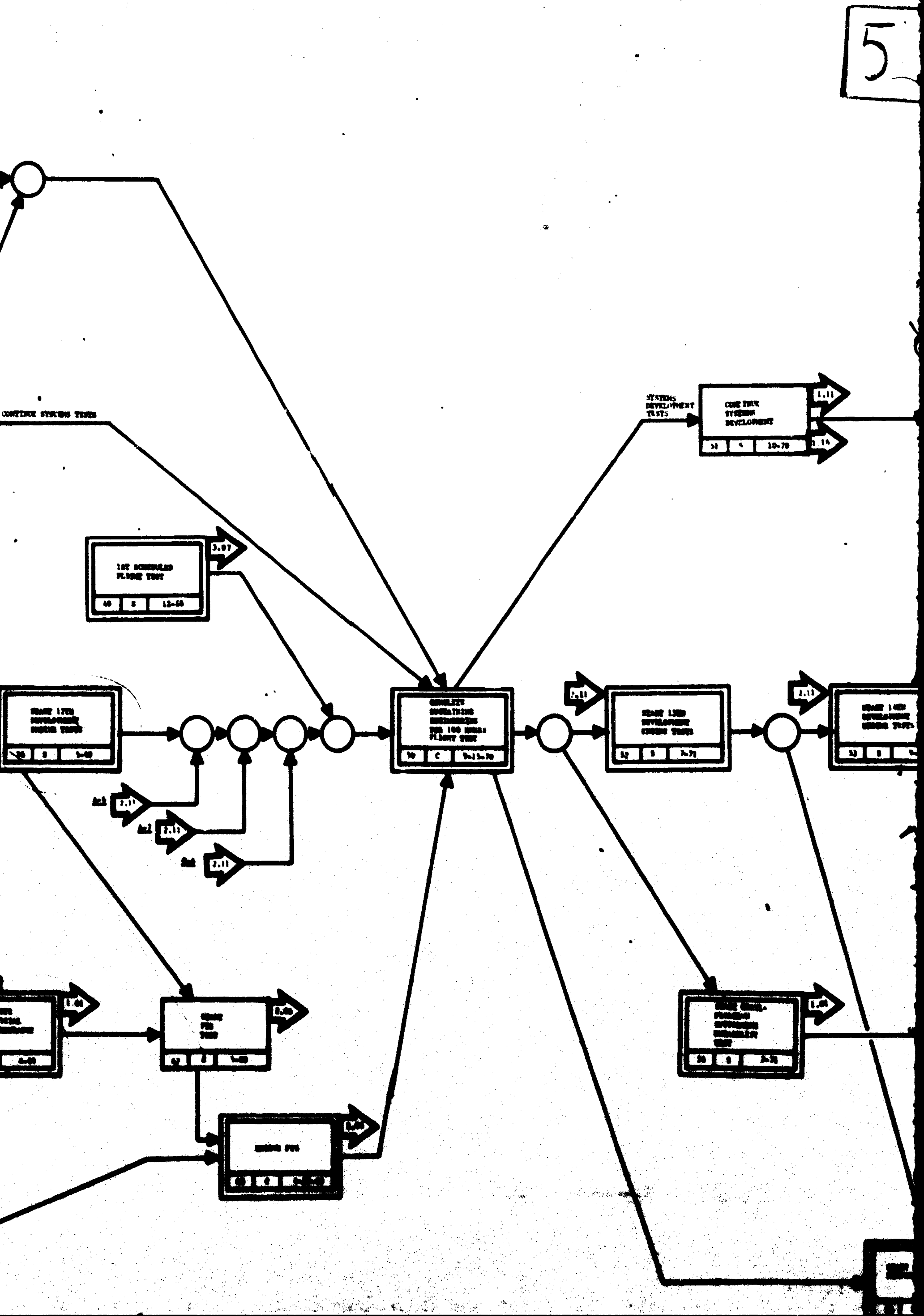
8
6-67
START ENGINE TESTS OF AUGMENTOR
1.01
1.14
5
8
7-67
CONTINUE SUBSYSTEM DEVELOPMENT
1.01
6-67
1.07
START CONTROL SYSTEM TESTS
1.16
14
7.67
START ENGINE NOISE TESTS
1.09
2.11
15
7-67
START ENGINE TESTS OF IGNITION SYSTEMS
16
8-67
START INLET DISTORTION TESTS
17
1.02
START 5TH DEVELOPMENT ENGINE TESTS
2.11
25
8
7-67
START 6TH DEVELOPMENT ENGINE TESTS
26
8
8-67
START TESTS OF FIRST REFURBISHED ENGINE
27
10-67

1.06 Engine 3


START ENGINE TESTS OF TURBINE
6 S 11-67
1.01
1.13
START ENGINE TESTS OF EXHAUST SYSTEM
7 S 2/68
1.15
START PRIMARY COMBUSTOR ENGINE TESTS
8 S 7-68
1.12
START ENGINE TESTS OF FTS AUGMENTOR CONFIGURATION
9 S 7-68
START INLET DISTORTION TESTS
17 S 11-67
1.11
1.08
START ENGINE TESTS OF ACCOUSTICAL LINERS
18 S 1-68
1.14
START INTEGRATED CONTROL SYSTEMS TESTS
19 S 6-68
1.16
START SIMULATED INLET TESTING
20 S 6-68
1.08
START TESTS OF SECOND REFURBISHED ENGINE
28 S 12-67
1.02
2.11
START TESTS OF THIRD REFURBISHED ENGINE
29 S 3-68
START 7TH DEVELOPMENT ENGINE TESTS
30 S 6-68
START 8TH DEVELOPMENT ENGINE TESTS
31 S 7-68
C-3

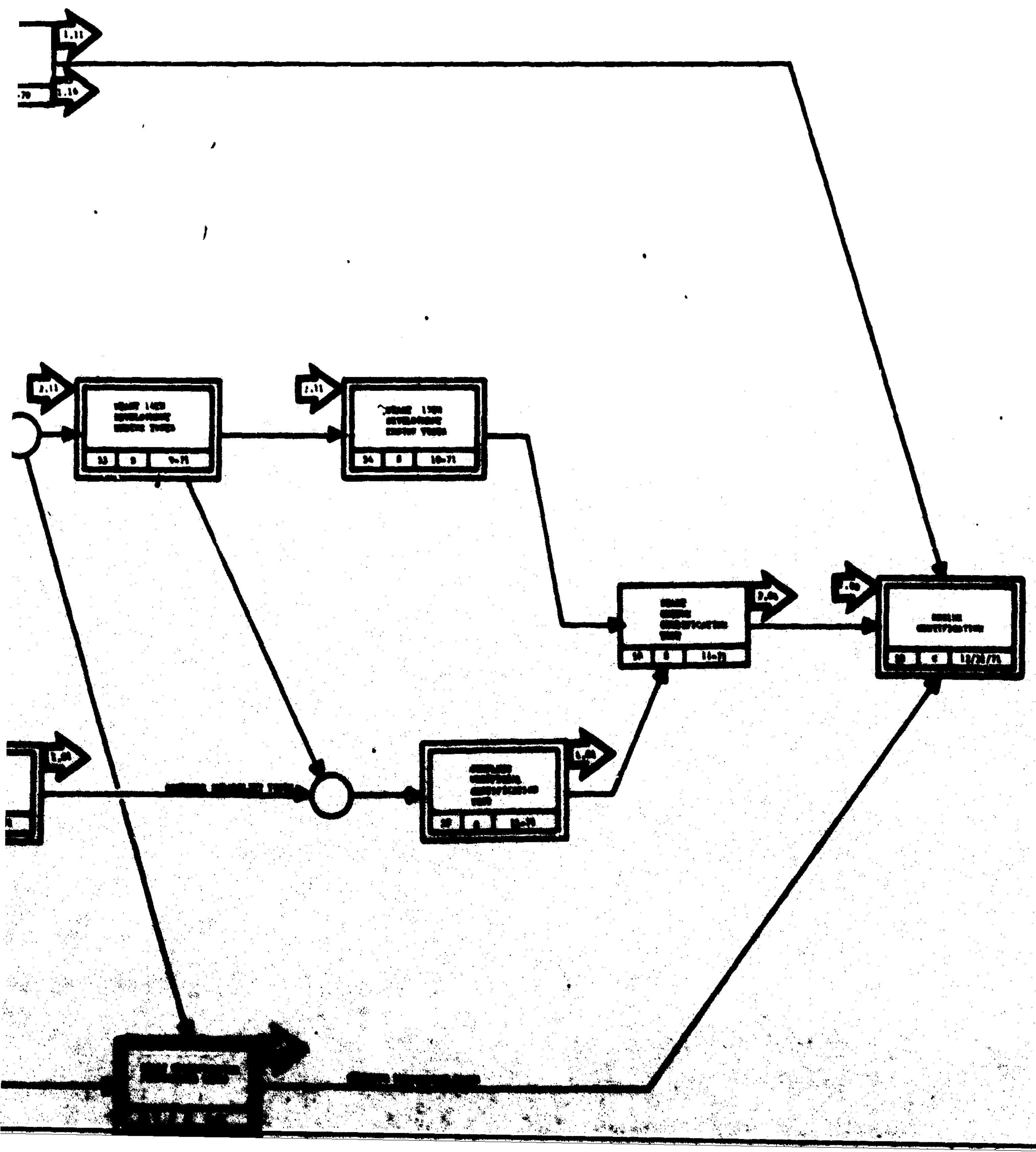
Engine Test-Ground

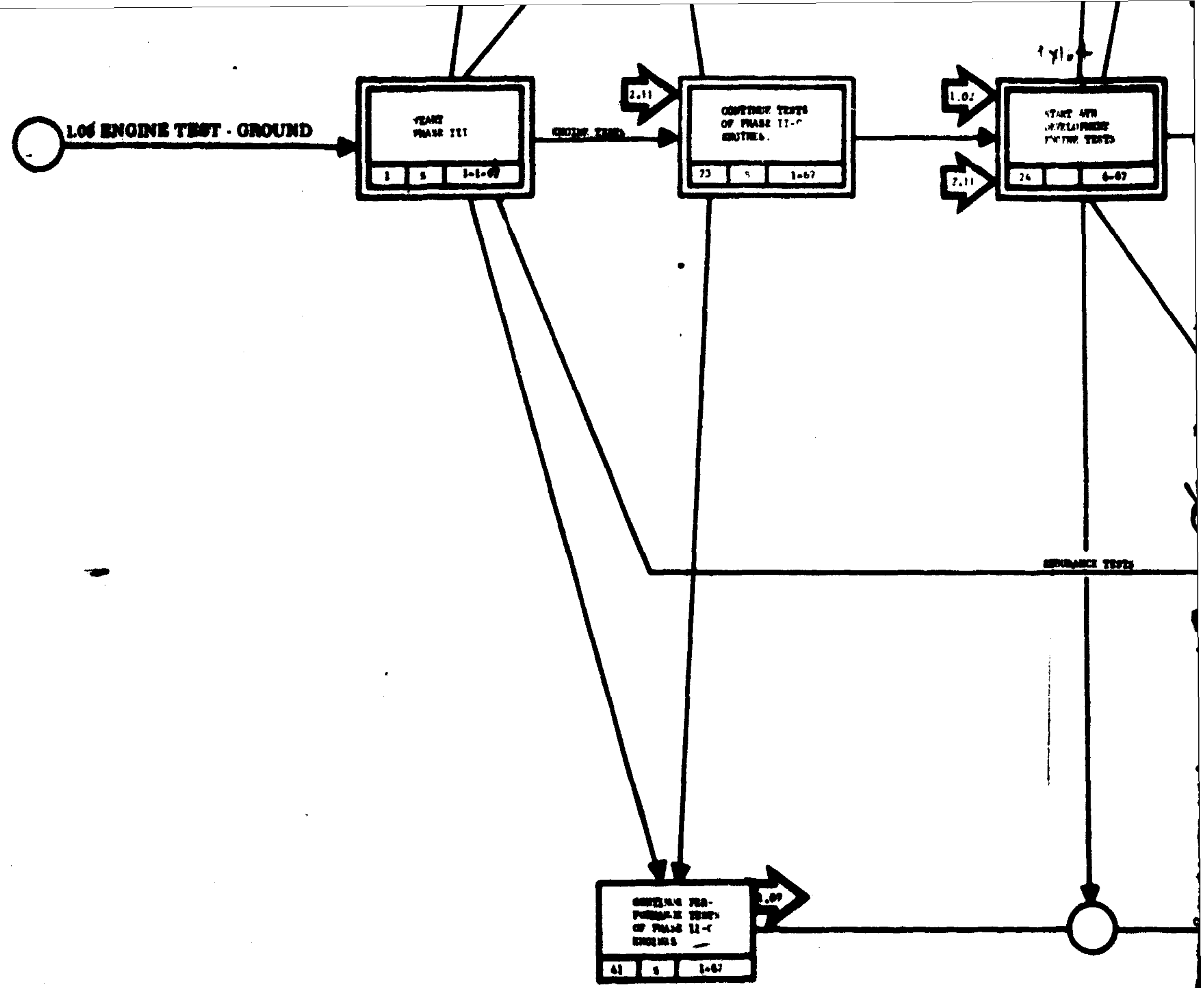



5
CONTINUE SYSTEMS TESTS
SYSTEMS
DEVELOPMENT
TESTS
1ST SCHEDULED
FLIGHT TEST
3.07
2.11

6

Figure12.

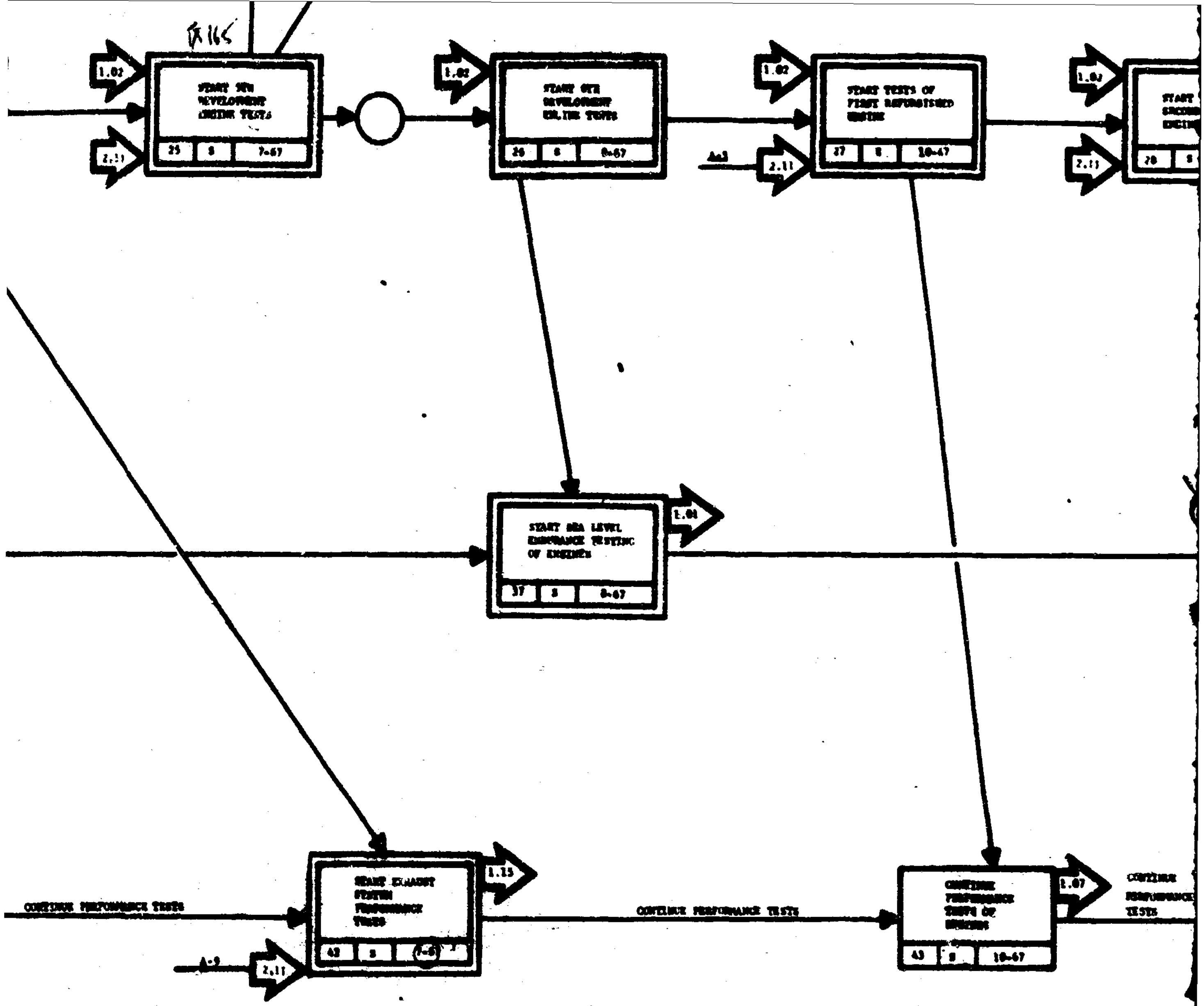




Event Number	Description and Criteria
1	START PHASE III Start of Phase III. Phase III go-ahead received from FAA.
2	CONTINUE SUBSYSTEM TESTS OF PHASE II-C ENGINES Continue tests of fan, compressor, turbine, combustor, augmentor and exhaust system. Engine tests in progress.
3	START DISTORTION TESTS WITH PHASE II-C ENGINES Start inlet distortion tests on Phase II-C engines to determine distortion parameters of fan and high compressor. Engine tests with inlet distortion in progress.
4	START PHASE III SUBSYSTEM TESTS Start engine tests of Phase III engine subsystems (i.e., fan, compressor, combustor, turbine, etc.). Test of 6th engine in progress.
5	START ENGINE TESTS OF AUGMENTOR Start engine tests to develop augmentor performance and durability. Engine tests of augmentor in progress.

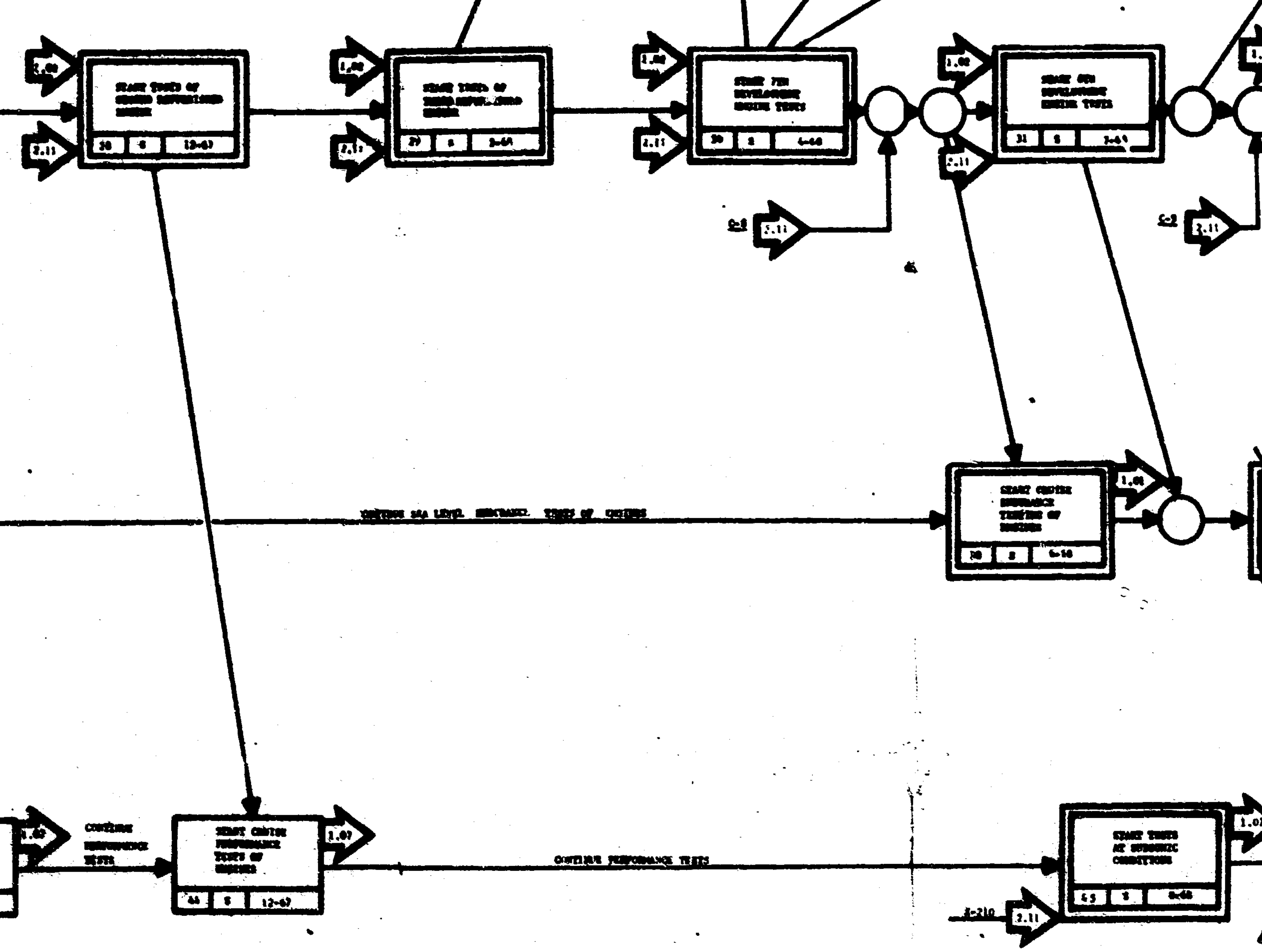
Event Number	Descri[illegible]
6	START ENGINE TESTS [illegible]
7	START ENGINE TEST[illegible]
8	START PRIMARY [illegible]
9	START ENGINE TEST[illegible]

Pratt & Whitney Aircraft
[illegible]



Description and Criteria	Event Number	Description and Criteria	Event Number	Description and Criteria
...TESTS OF TURBINE ...tests to develop turbine durability ...e. Engine tests of turbine in	10	**START ALTITUDE RELIGHT TESTS** Start relight calibrations of the JTF17 main combustor and augmentor in FRDC altitude facility or Willgoos Turbine Laboratory. Engine tests of relight capabilities in progress	15	**START ENGINE NOISE TESTS** Start test programs to determine... engine at various rotor speeds a... augmentor liner modifications. ... noise level in progress.
...TESTS OF EXHAUST SYSTEM ...tests to develop exhaust system ...d durability. Engine tests of ... in progress.	11	**START TESTS OF FTS PRIMARY COMBUSTOR DESIGNS** Start engine tests of refined combustor configurations selected for FTS engine. Engine tests of FTS combustor in progress.	16	**START ENGINE TESTS OF IGNITION ...** Start engine tests to determine ... teristics of refined ignition sy... Engine tests of ignition syst...
...COMBUSTOR ENGINE TESTS ...tests to develop primary combustor ...rmance and durability. Engine ...ry combustor in progress.	12	**START ENGINE SYSTEMS TESTS** Start engine tests of major engine systems. Engine tests of major systems in progress.	17	**START INLET DISTORTION TESTS** Start test programs on engines ... tortion parameters of the fan a... Engine tests of inlet distortio...
...TESTS OF FTS AUGMENTOR CONFIGURATION ...tests of refined augmentor configura- ...d as candidates for FTS engine. ...of FTS augmentor in progress.	13	**START TESTS OF INLET COMPATIBILITY, THRUST BALANCE, FUEL AND LUBE SYSTEM** Start engine tests of major engine systems to determine operational characteristics, performance, and durability. Engine tests in progress.	18	**START ENGINE TESTS OF ACOUSTICA...** Start test programs on engines ... effects of acoustical liners in ... levels. Engine tests of acoust... progress.
	14	**START CONTROL SYSTEM TESTS** Start engine tests of engine control systems to determine performance, durability and operating characteristics. Control system tests in progress.		

8

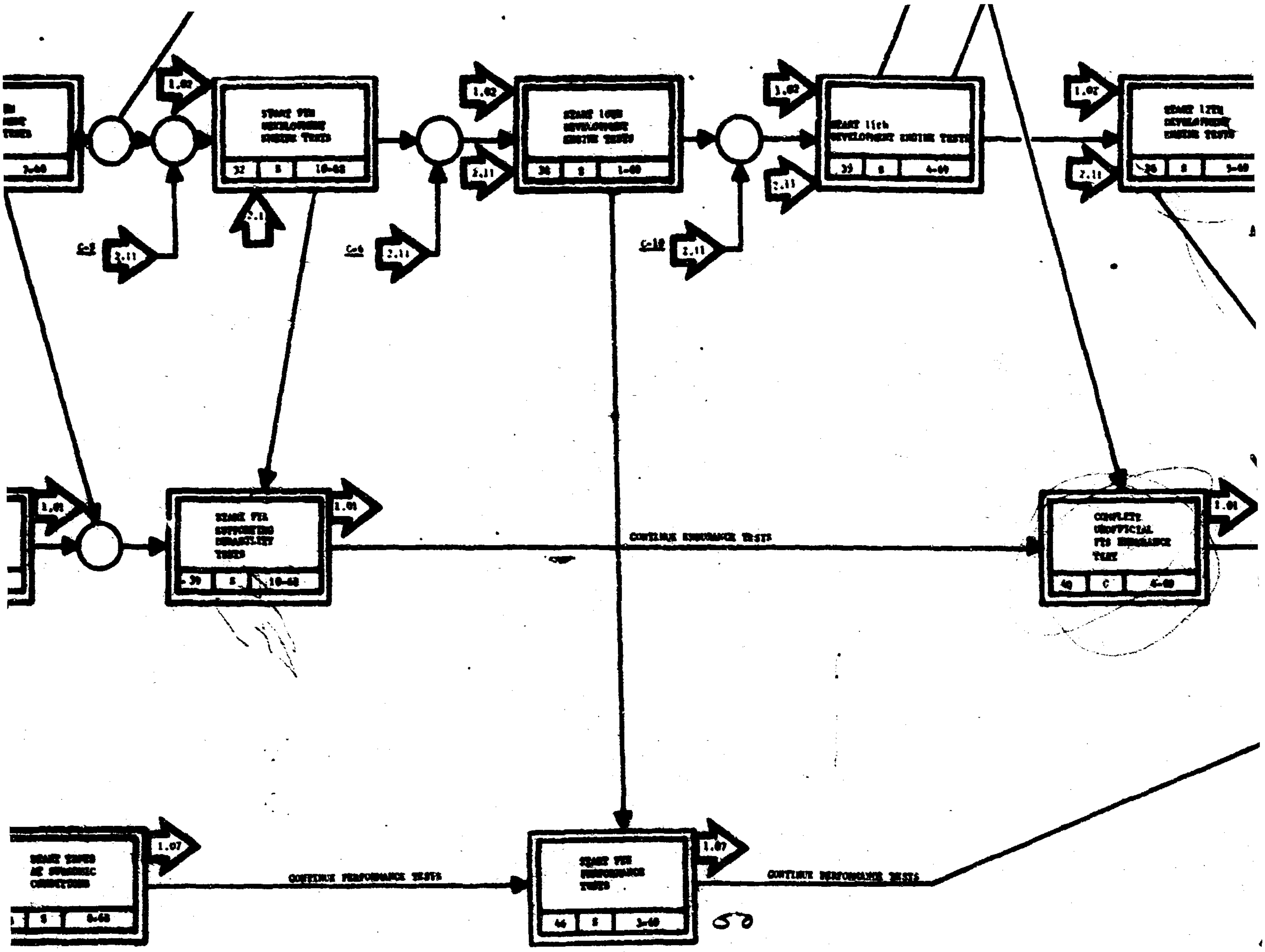


Description and Criteria
...NGINE NOISE TESTS ...test programs to determine noise level of ... at various rotor speeds and with various ...tor liner modifications. Engine tests of ...evel in progress.
...NGINE TESTS OF IGNITION SYSTEM ...engine tests to determine operating charac-...ics of refined ignition system designs. ... tests of ignition system in progress.
...INLET DISTORTION TESTS ...test programs on engines to determine dis-... parameters of the fan and high compressor. ... tests of inlet distortion in progress.
...NGINE TESTS OF ACOUSTICAL LINERS ...test programs on engines to determine ... of acoustical liners in reducing PNdb ... Engine tests of acoustical liners in ...ss.

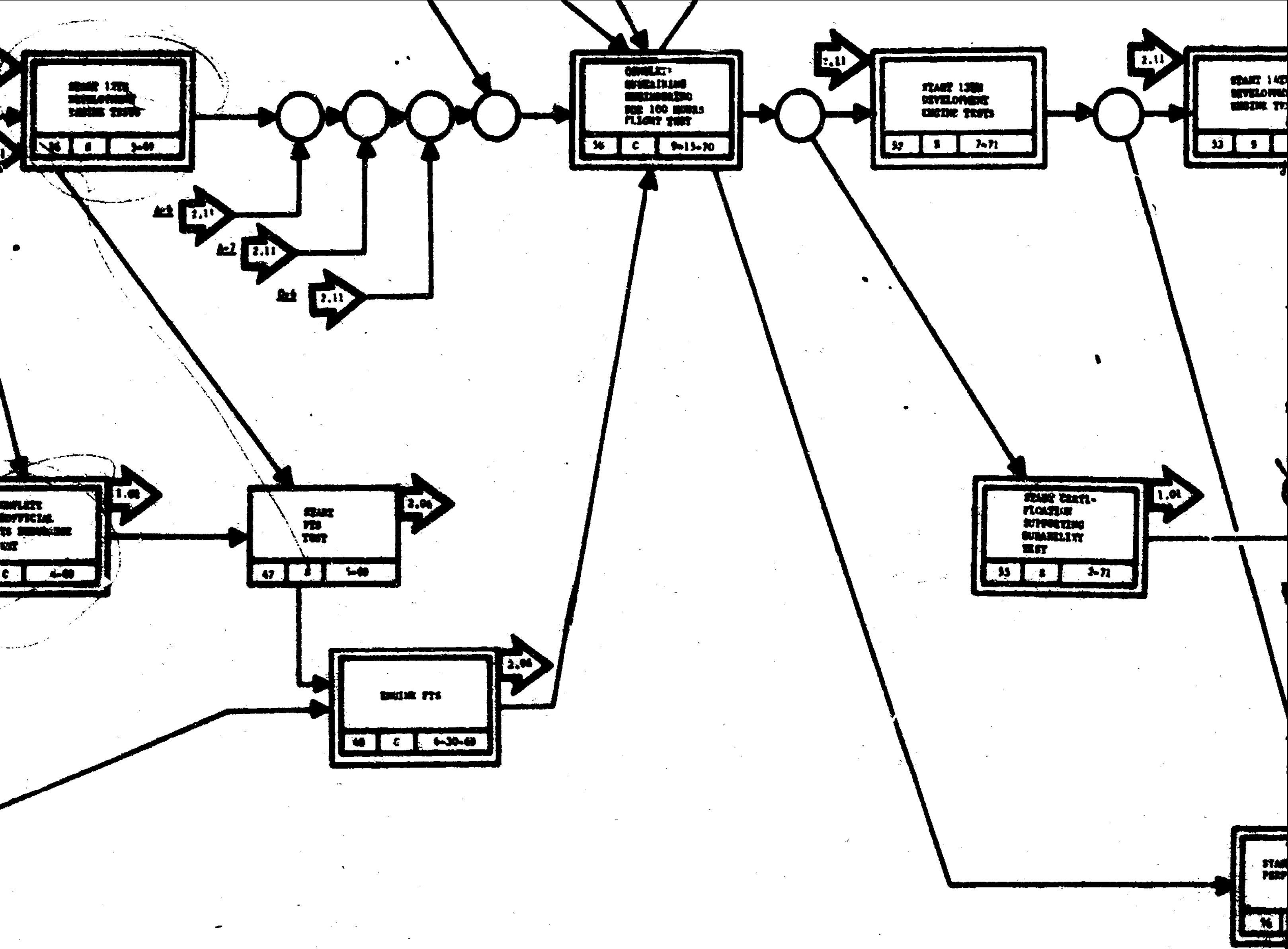
Event Number	Description and Criteria
19	START INTEGRATED CONTROL SYSTEM TESTS Start engine tests of complete, fully integrated control systems to determine operating character-istics and repeatability. Engine tests of integrated control system in progress.
20	START SIMULATED INLET TESTING Start test programs with simulated inlets to determine compatibility of engine/inlet system. Engine tests with simulated inlets in progress.
21	COMPLETE HEAT REJECTION TESTS Complete heat rejection tests on engines to determine bearing compartment heat loads and cooling requirements. Heat rejection data analysis completed.
22	START AEDC ENGINE PERFORMANCE TEST OF EXHAUST SYSTEM Start performance tests of engine exhaust system in AEDC facilities. Performance test at AEDC in progress.
23	CONTINUE TESTS OF PHASE II-C ENGINES Continue engine testing of Phase II-C engines during early part of Phase III. Start engine tests after Phase III go-ahead.

Event Number	Description and Criteria
24	START 4TH DEVELOPMENT ENGINE TESTS Start tests on 1st new JTF17 development engi... Initial test in progress.
25	START 5TH DEVELOPMENT ENGINE TESTS Start tests of 2nd new JTF17 development engi... Initial test in progress.
26	START 6TH DEVELOPMENT ENGINE TESTS Start tests of 3rd new JTF17 development engi... Initial test in progress.
27	START TESTS OF 1ST REFURBISHED ENGINE Start tests on first refurbished Phase II-C engine converted to development configuration... Initial test in progress.
28	START TESTS OF 2ND REFURBISHED ENGINE Start tests of 2nd refurbished Phase II-C engine converted to development configuration, Initial test in progress.

9

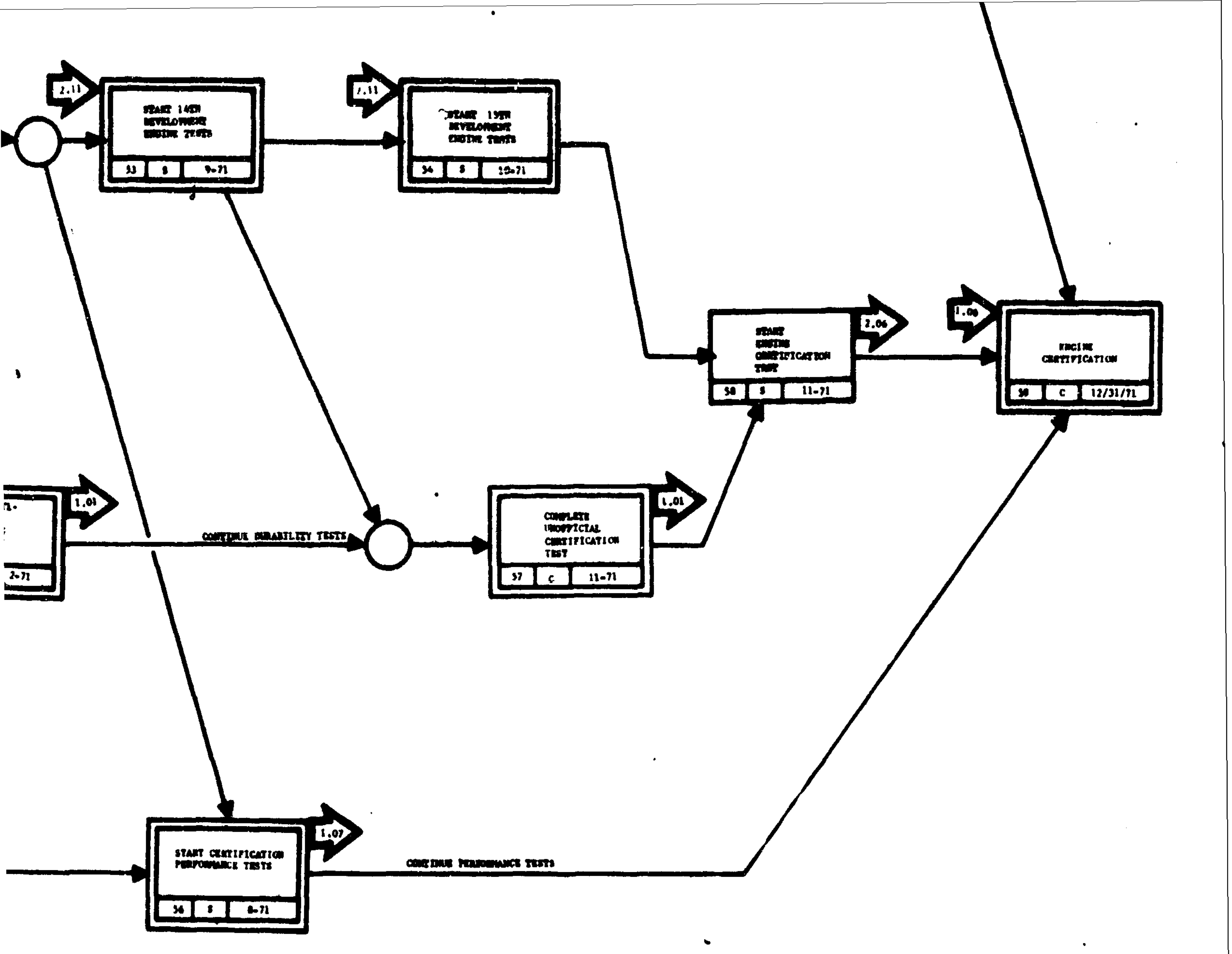


	Event Number	Description and Criteria	Event Number	Description and Criteria
...ion and Criteria				
...MENT ENGINE TESTS ...t new JTF17 development engine. ...rogress.	29	START TESTS OF 3RD REFURBISHED ENGINE Start tests of 3rd refurbished Phase II-C engine converted to development configuration. Initial test in progress.	35	START 11TH DEVELOPMENT ENGINE TESTS Start tests of 8th new JTF17 development engine. Initial test in progress.
...MENT ENGINE TESTS ...d new JTF17 development engine. ...rogress.	30	START 7TH DEVELOPMENT ENGINE TESTS Start tests of 4th new JTF17 development engine. Initial test in progress.	36	START 12TH DEVELOPMENT ENGINE TESTS Starts tests of 9th new JTF17 development engine. Initial test in progress.
...MENT ENGINE TESTS ...d new JTF17 development engine. ...rogress.	31	START 8TH DEVELOPMENT ENGINE TESTS Start tests of 5th new JTF17 development engine. Initial test in progress.	37	START SEA LEVEL ENDURANCE TESTING OF ENGINES Start sea level endurance testing of JTF17 development engines to evaluate durability. Endurance testing in progress.
...T REFURBISHED ENGINE ...rst refurbished Phase II-C ...to development configuration. ...rogress.	32	START 9TH DEVELOPMENT ENGINE TESTS Start tests of 6th new JTF17 development engine. Initial test in progress.	38	START CRUISE ENDURANCE TESTING OF ENGINES Start cruise endurance testing of JTF17 development engines to evaluate durability. Cruise endurance test in progress.
...D REFURBISHED ENGINE ...d refurbished Phase II-C ...to development configuration. ...rogress.	33	START AEDC ENGINE TESTS Start inlet compatibility tests of engine/inlet system in AEDC facilities. Initial test at AEDC in progress.	39	START PTS SUPPORTING DURABILITY TESTS Start durability testing on JTF17 development engines with refined PTS configuration subsystems. Durability test in progress.
	34	START 10TH DEVELOPMENT ENGINE TESTS Start tests of 7th new JTF17 development engine. Initial test in progress.		



...ria	Event Number	Description and Criteria	Event Number	Description and Criteria	Event N...
... TESTS ...development engine.	40	COMPLETE UNOFFICIAL FTS ENDURANCE TEST Complete FTS endurance cycle test for FTS review. Remove engine from test stand.	44	START CRUISE PERFORMANCE TESTS OF ENGINES Start engine performance tests at cruise conditions to define performance parameters. Engine tests at cruise conditions in progress.	49
... TESTS ...development engine.	41	CONTINUE PERFORMANCE TESTS OF PHASE II-C ENGINES Continue performance testing of Phase II-C engines to define cycle efficiency and performance parameters. Resume testing after Phase III go-ahead.	45	START TESTS AT SUBSONIC CONDITIONS Start tests of JTF17 engines at subsonic conditions on X-210 stand. Initial test on X-210 stand in progress.	50
...TING OF ENGINES ...ting JTF17 ...e durability.	42	START EXHAUST SYSTEM PERFORMANCE TESTS Start engine tests to evaluate exhaust system performance and operational characteristics. Initial test of engine for exhaust system performance in progress.	46	START FTS PERFORMANCE TESTS Start engine performance tests of JTF17 prototype engine at operating points specified in Model Specification. Performance tests in progress.	
... OF ENGINES ...g of JTF17 develop-...bility. Cruise	43	CONTINUE PERFORMANCE TESTS OF ENGINES Continue performance testing of JTF17 development engines. Engine performance tests in progress.	47	START FTS TEST Start official FTS endurance test. First cycle of endurance in progress.	52
...Y TESTS ...TF17 development ...iguration sub-...progress.			48	ENGINE FTS Complete final acceptance test following a 75-hour endurance test on a JTF17 Parts List engine. Engine parameters must be within limits specified in Model Specification during final acceptance test.	[illegible]

11



ENGINES
...imilar condi-
...ers. Engine
...ress.

...sonic condi-
... on X-210

JTF17 proto...
...ified in
...ests in

First cycle

...owing a 25-
...s List engine.
...mits specified
acceptance

Event Number	Description and Criteria
49	**1ST SCHEDULED FLIGHT TEST** Perform 1st scheduled flight test of airframe/engine prototype configuration. Complete first flight.
50	**COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST** End of Phase III. Complete 100 hours of flight testing.
51	**CONTINUE SYSTEMS DEVELOPMENT** Continue systems development for engine certification configuration. System development in progress after completion of 100 hours of flight testing.
52	**START 13TH DEVELOPMENT ENGINE TESTS** Start tests on 10th new JTF17 development engine. Initial test in progress.
53	**START 14TH DEVELOPMENT ENGINE TESTS** Start tests on 11th new JTF17 development engine. Initial test in progress.

Event No.	Description and Criteria
54	**START 15TH DEVELOPMENT ENGINE TESTS** Start tests of 12th new JTF17 development engine. Initial test in progress
55	**START CERTIFICATION SUPPORTING DURABILITY TESTS** Start durability testing of certification configurations in engines. Engine test of certification configurations in progress.
56	**START CERTIFICATION PERFORMANCE TESTS** Start performance tests of JTF17 engine at operating points defined in Model Specification. Performance test in progress.
57	**COMPLETE UNOFFICIAL CERTIFICATION TEST** Complete unofficial certification endurance test on JTF17 Parts List engine for certification review. Remove engine from test stand.
58	**START ENGINE CERTIFICATION TEST** Start official certification test. First cycle of endurance in progress.
59	**ENGINE CERTIFICATION** Complete final acceptance test following a 150-hour endurance test on a JTF17 Parts List engine. Engine parameters must be within limits specified in Model Specification during final acceptance test.

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1.07 ENGINE PERFORMANCE

Performance analysis of the JTF17 development engine will continue throughout Phase III and include data reduction, processing and analysis of all development engines and component rigs. Based on the results and the engine requirements, test programs will be designed to obtain the maximum relevant information from the minimum number of tests. Component performance analysis will be continued to ensure that the engine requirements for the component are reflected in the development program and to continuously rematch the development engines to take advantage of the latest component configuration. A digital computer simulation of the latest development engine configuration will be maintained.

Matching studies will be conducted to ensure that the engine configuration is based on the best use of its respective components. Special studies, such as tradeoffs for airbleed systems, power extraction, inlet-engine optimization emergency requirements, starting and heat rejection, will be continued to support the airframe manufacturer.

The analysis of noise, methods to attenuate noise, and methods to take advantage of the turbofan cycle to reduce noise will be continued throughout Phase III. Test programs will be designed to develop attenuation methods and to study the mechanism of noise generation within the engine. The water table will be used as a hydraulic analog for analysis of turbulent mixing regions as they relate to noise.

Steady-state digital computer simulations will be maintained and updated for the JTF17 production engine at Pratt & Whitney Aircraft, the airframe manufacturer and an agency designated by the Federal Aviation Agency. Transient simulation on analog, digital and hybrid analog-digital computers will be updated and provided to the same agencies. The transient simulations will include a dynamic representation of the inlet supplied by the airframe manufacturer.

Control analysis will continue and include the determination of control schedules; the dynamic analysis of the engine and control system; and the analysis of the interaction between the engine, control system, the inlet, and the inlet control system. This latter activity is part of the overall inlet-engine compatibility study which also includes the optimization of airflow relationships between the inlet and the engine and the effect of inlet generated distortion on the engine.

Statistical engineering is an integral part of performance and analysis, and particular emphasis will be placed on the following:

1. Planning and designing experimental programs
2. Instrumentation, precision and accuracy analysis
3. Selection and calibration methods for engine and component instrumentation
4. Analysis of experimental data including correlation regression and analysis of variance
5. Monte Carlo simulation for systems including stochastic elements

6. The assurance that correct inferences are made from experimental results

7. A measurement of the risk of error associated with conclusions and recommendations based on experimental results.

Final optimization of the engine will be based on analysis of the airplane mission including range, payload, economics, safety, noise and growth potential. This activity requires the maintenance of airplane performance digital simulation, extensive knowledge of various airline route structures for the supersonic transport and the Federal Aviation Agency requirements for airplane operation. Emergency conditions such as loss of cabin pressurization, engine failure, and diversion to alternate airports are included in these studies.

The major milestones, network chart and event dictionary for engine performance are shown in figures 13 and 14, respectively.

A detailed description of engine performance is presented in Volume III, Report A, and test planning and integration is presented in Test, Volume IV, Report E.

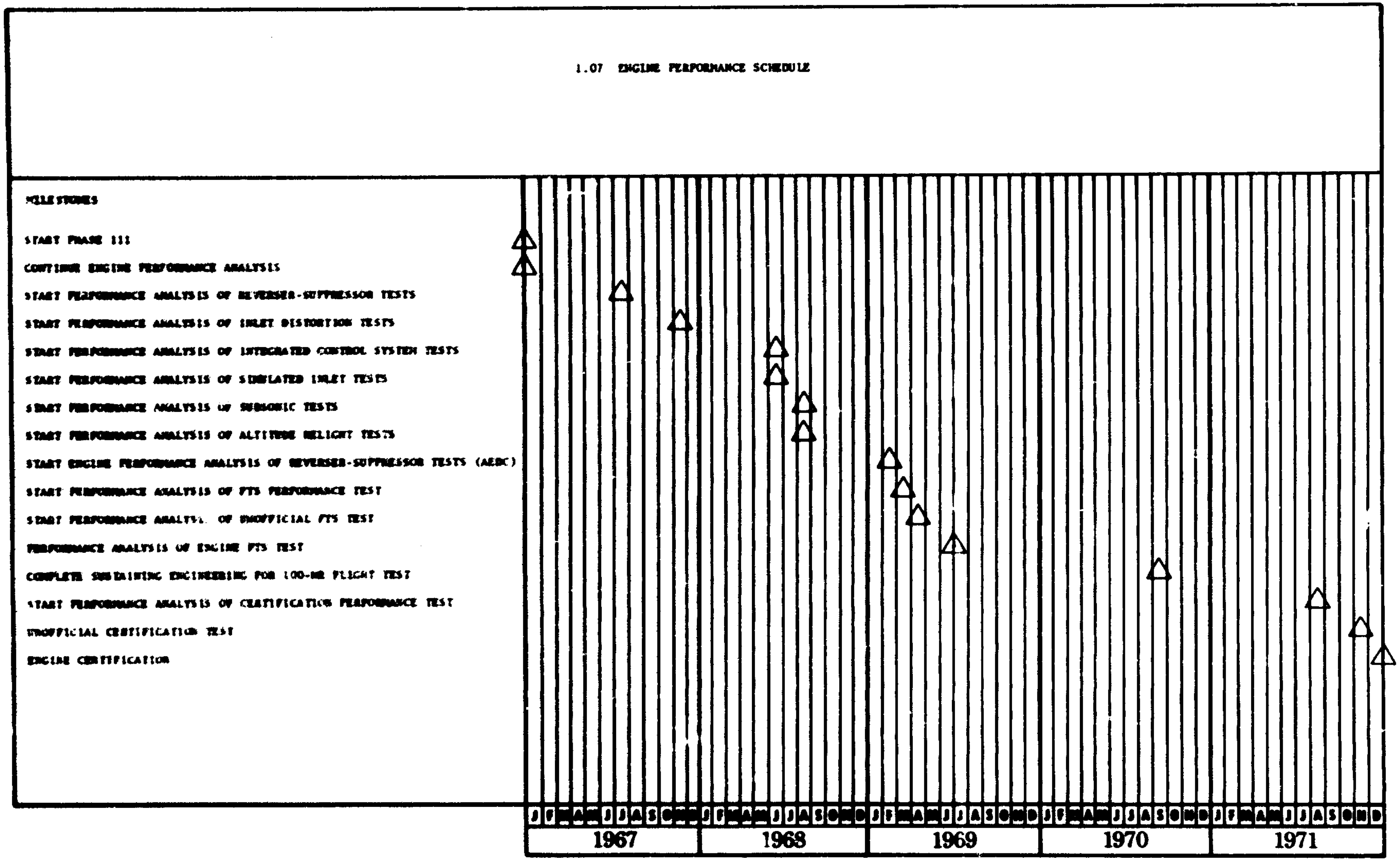

Figure 13. 1.07 Engine Performance

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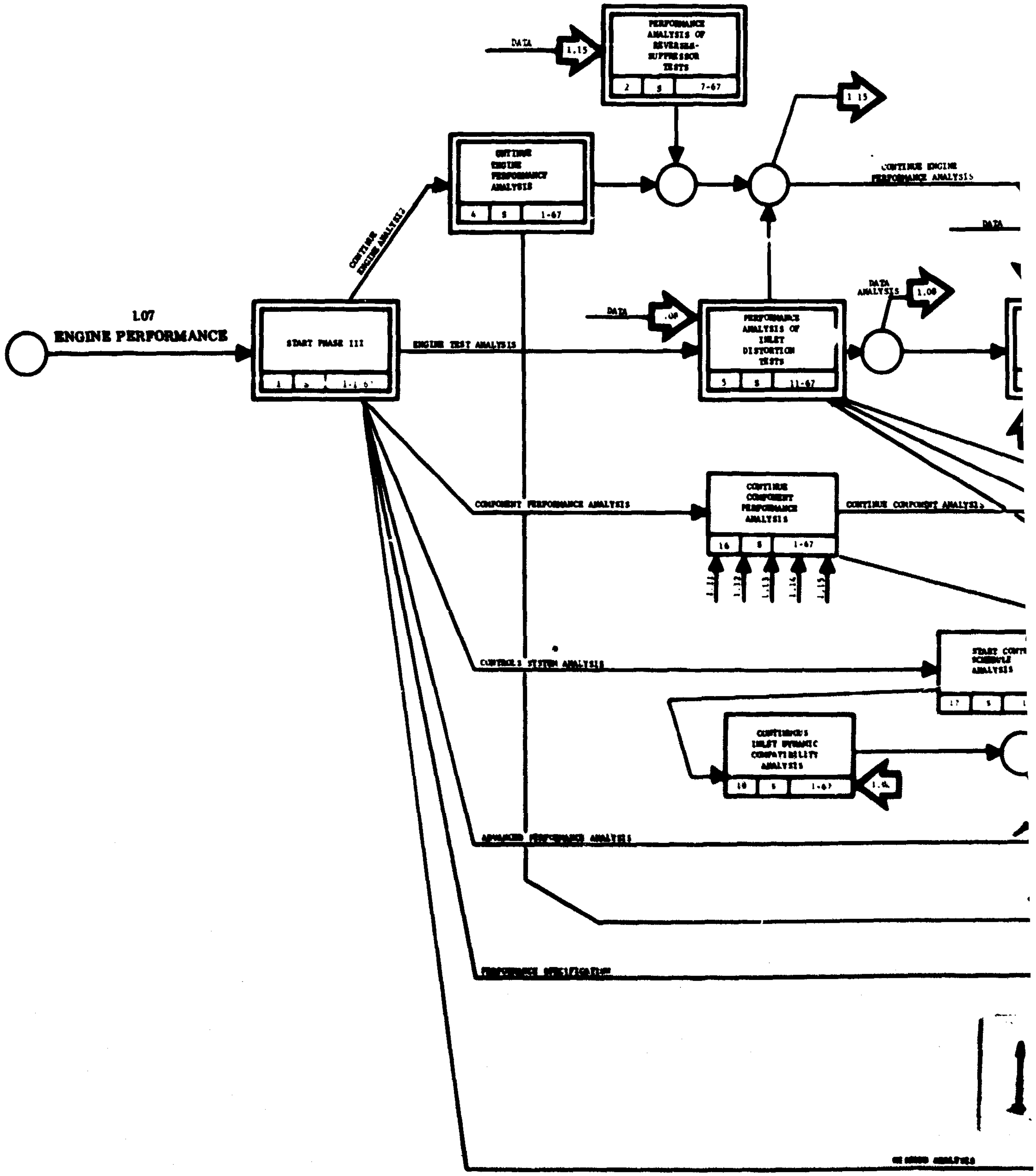
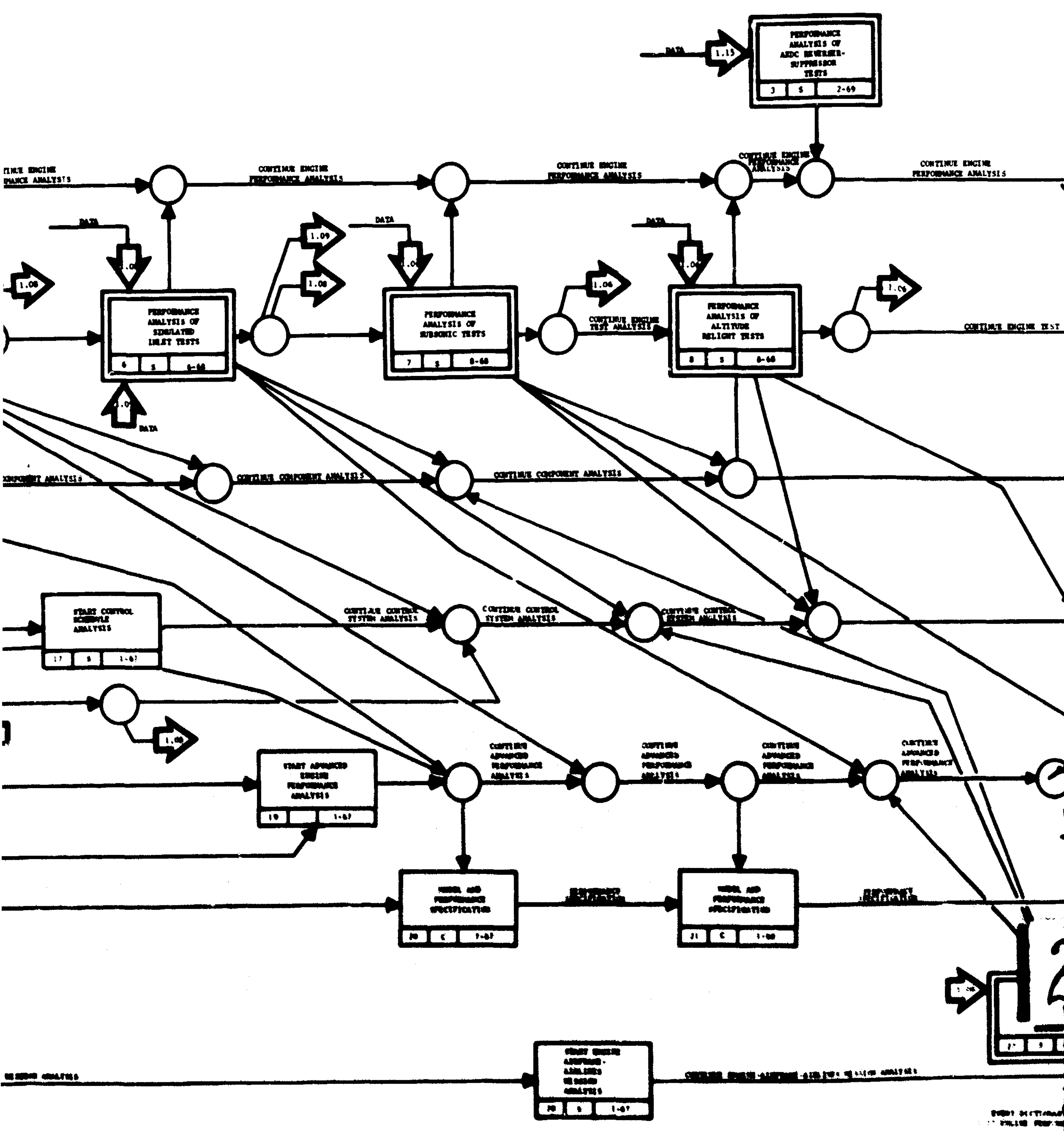
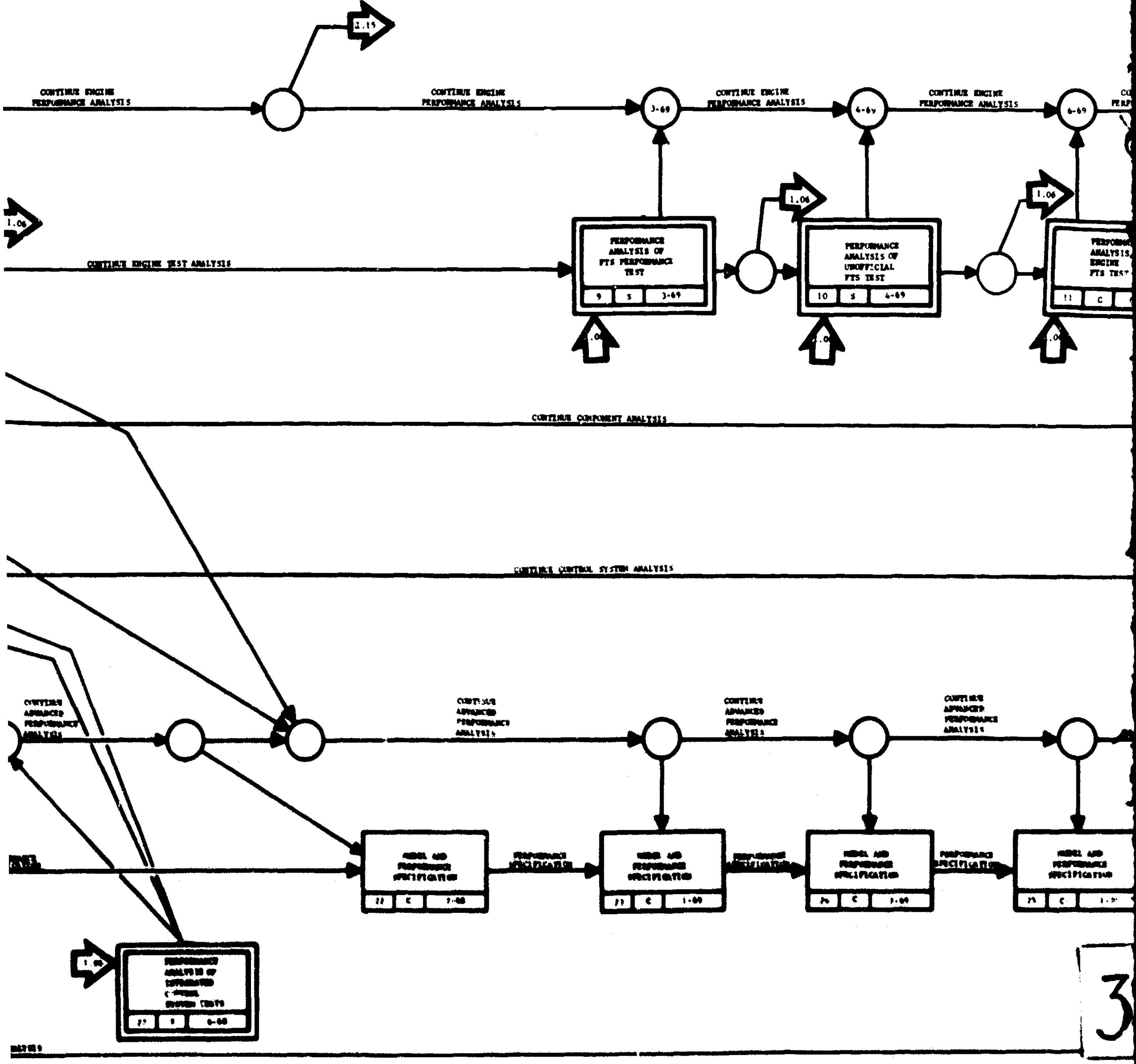

1.07
ENGINE PERFORMANCE
START PHASE III
CONTINUE ENGINE PERFORMANCE ANALYSIS
4
5
1-67
DATA
1.15
PERFORMANCE ANALYSIS OF REVERSER-SUPPRESSOR TESTS
2
5
7-67
1.15
CONTINUE ENGINE PERFORMANCE ANALYSIS
DATA
ENGINE TEST ANALYSIS
PERFORMANCE ANALYSIS OF INLET DISTORTION TESTS
5
5
11-67
DATA ANALYSIS
1.08
COMPONENT PERFORMANCE ANALYSIS
CONTINUE COMPONENT PERFORMANCE ANALYSIS
16
5
1-67
CONTINUE COMPONENT ANALYSIS
CONTROLS SYSTEM ANALYSIS
CONTINUOUS INLET DYNAMIC COMPATIBILITY ANALYSIS
10
5
1-67
ADVANCED PERFORMANCE ANALYSIS
PERFORMANCE SPECIFICATION



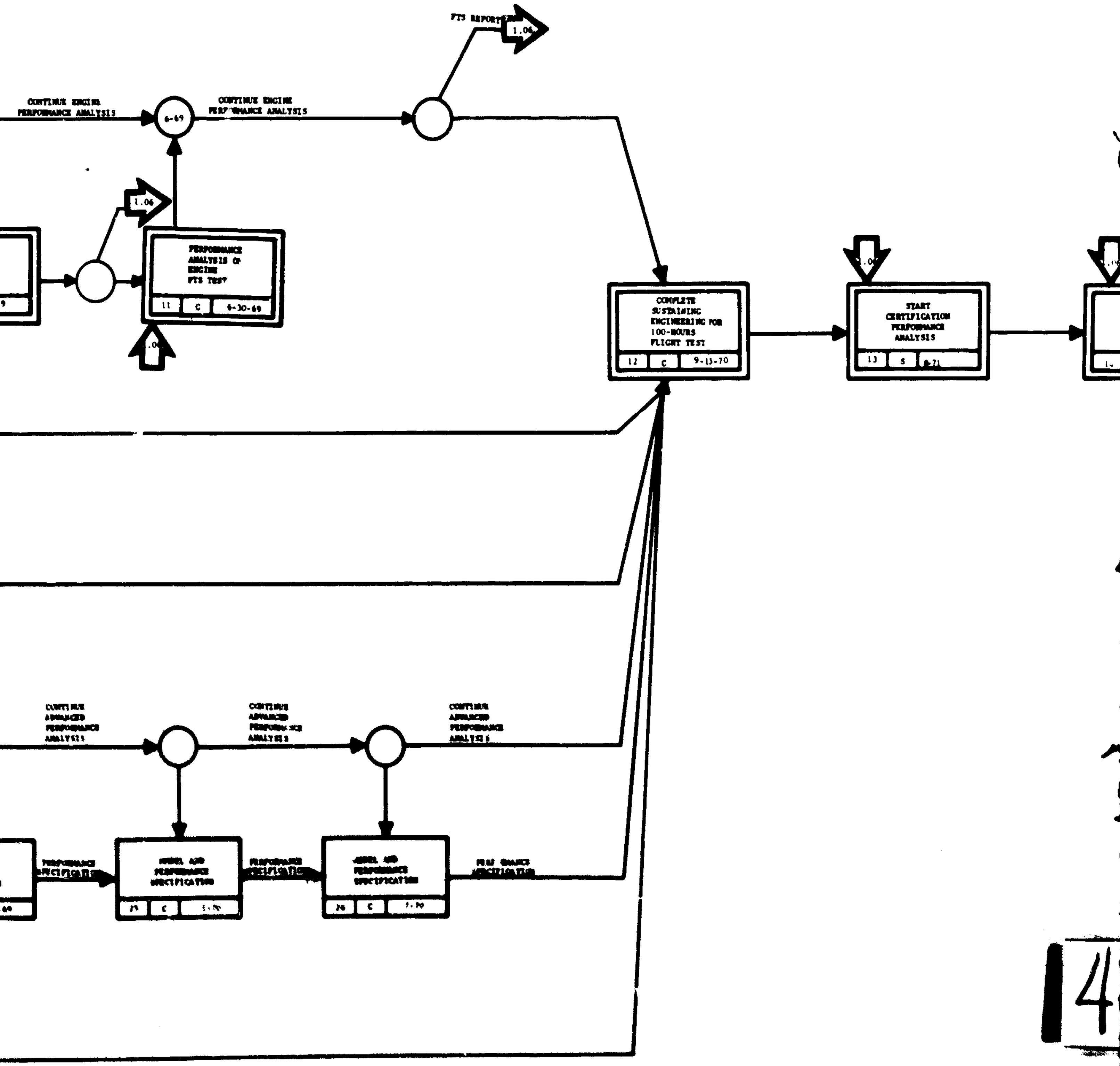
Event Number	Description and Criteria	Event Number	Description and Criteria
1	START PHASE III Phase III go-ahead received from ...	6	PERFORMANCE ANALYSIS OF SIMULATED INLET TESTS Start analysis of data from simulated inlet tests. Analysis of data is in process
2	PERFORMANCE ANALYSIS OF REVERSER-SUPPRESSOR TESTS Start analysis of reverser-suppressor test data. Analysis of incoming data is in process	7	PERFORMANCE ANALYSIS OF SUBSONIC TESTS Start analysis of data from subsonic tests. Analysis of data is in process
3	PERFORMANCE ANALYSIS OF AEDC REVERSER-SUPPRESSOR TESTS Start analysis of AEDC reverser-suppressor test data. Analysis of incoming test data is in process	8	PERFORMANCE ANALYSIS OF ALTITUDE RELIGHT TESTS Start performance analysis of data from altitude relight tests. Analysis of data is in process
4	CONTINUE ENGINE PERFORMANCE ANALYSIS Continue analysis of engine test data. Analysis of data is in process	9	PERFORMANCE ANALYSIS OF PTS PERFORMANCE TEST Start analysis of data from engine PTS test. Analysis of data is in process.
		10	PERFORMANCE ANALYSIS OF [illegible] PTS TEST

1.07 Engine Performance



EVENT DICTIONARY
1.07 ENGINE PERFORMANCE

Description and Criteria	Event Number	Description and Criteria	Event Number	Description and Criteria
COMPLETE [illegible] FLIGHT TEST End of Phase III. Completion of [illegible] hours of flight testing	18	CONTINUOUS [illegible] DYNAMIC COMPATIBILITY ANALYSIS Start continuing analysis of dynamic compatibility to date. Analysis of data is in process	[illegible]	MODEL AND PERFORMANCE SPECIFICATION Complete update of engine model performance specification. Issue preliminary sp[illegible]
FIRST CERTIFICATION PERFORMANCE ANALYSIS Start analysis of data from Certification performance test. Analysis of data is in process	19	START ADVANCED ENGINE PERFORMANCE ANALYSIS Start analysis of advanced engine performance. Analysis is in process	23	MODEL AND PERFORMANCE SPECIFICATION Complete update of engine model performance specification. Issue preliminary sp[illegible]
UNOFFICIAL CERTIFICATION TEST Reference engine network 1.06 for description and criteria	20	MODEL AND PERFORMANCE SPECIFICATION Complete update of engine model and performance specification. Issue preliminary specification	26	MODEL AND PERFORMANCE SPECIFICATION Complete update of engine model performance specification. Issue preliminary sp[illegible]
ENGINE CERTIFICATION Reference engine network 1.06 for description and criteria	21	MODEL AND PERFORMANCE SPECIFICATION Complete update of engine model and performance specification. Issue preliminary specification.	27	PERFORMANCE ANALYSIS OF INTEGRATED CONTROL SYSTEM TESTS Start analysis of data from integrated control system tests. Analysis of data is in proc[illegible]
CONTINUE COMPONENT PERFORMANCE ANALYSIS Continue analysis of component test data	22	MODEL AND PERFORMANCE SPECIFICATION Complete update of engine model and performance specification. [illegible]	30	[illegible]



14

Description and Criteria

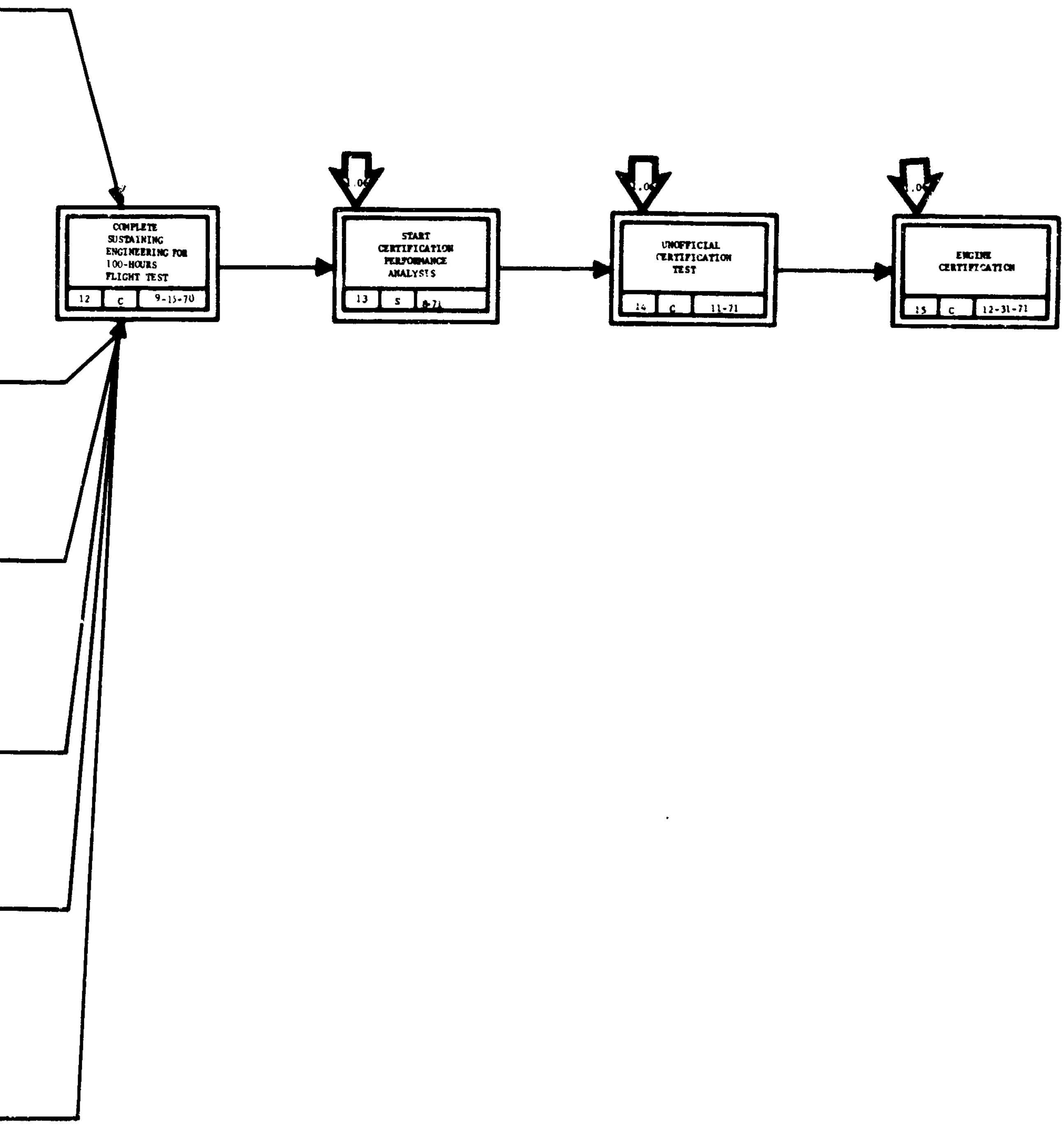
MODEL AND PERFORMANCE SPECIFICATION
Complete update of engine model performance specification. Issue preliminary specification.

MODEL AND PERFORMANCE SPECIFICATION
Complete update of engine model performance specification. Issue preliminary specification.

MODEL AND PERFORMANCE SPECIFICATION
Complete update of engine model performance specification. Issue firm specification.

PERFORMANCE ANALYSIS OF INTEGRATED CONTROL SYSTEM TESTS
Start analysis of data from integrated control system tests. Analysis of data is in process.

[illegible]


COMPLETE SUSTAINING ENGINEERING FOR 100-HOURS FLIGHT TEST
12
C
9-15-70
START CERTIFICATION PERFORMANCE ANALYSIS
13
S
UNOFFICIAL CERTIFICATION TEST
14
C
11-71
ENGINE CERTIFICATION
15
C
12-31-71

5

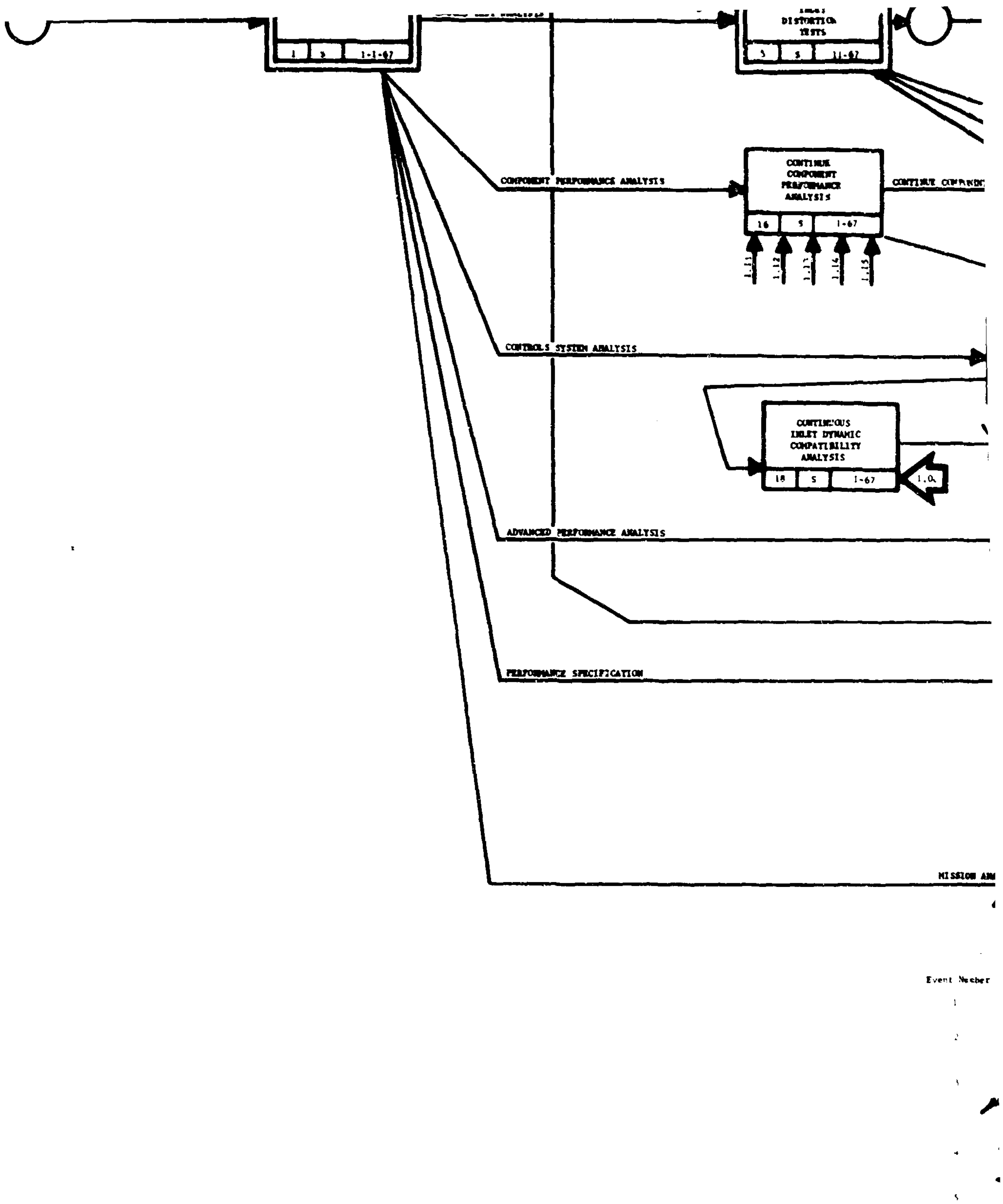
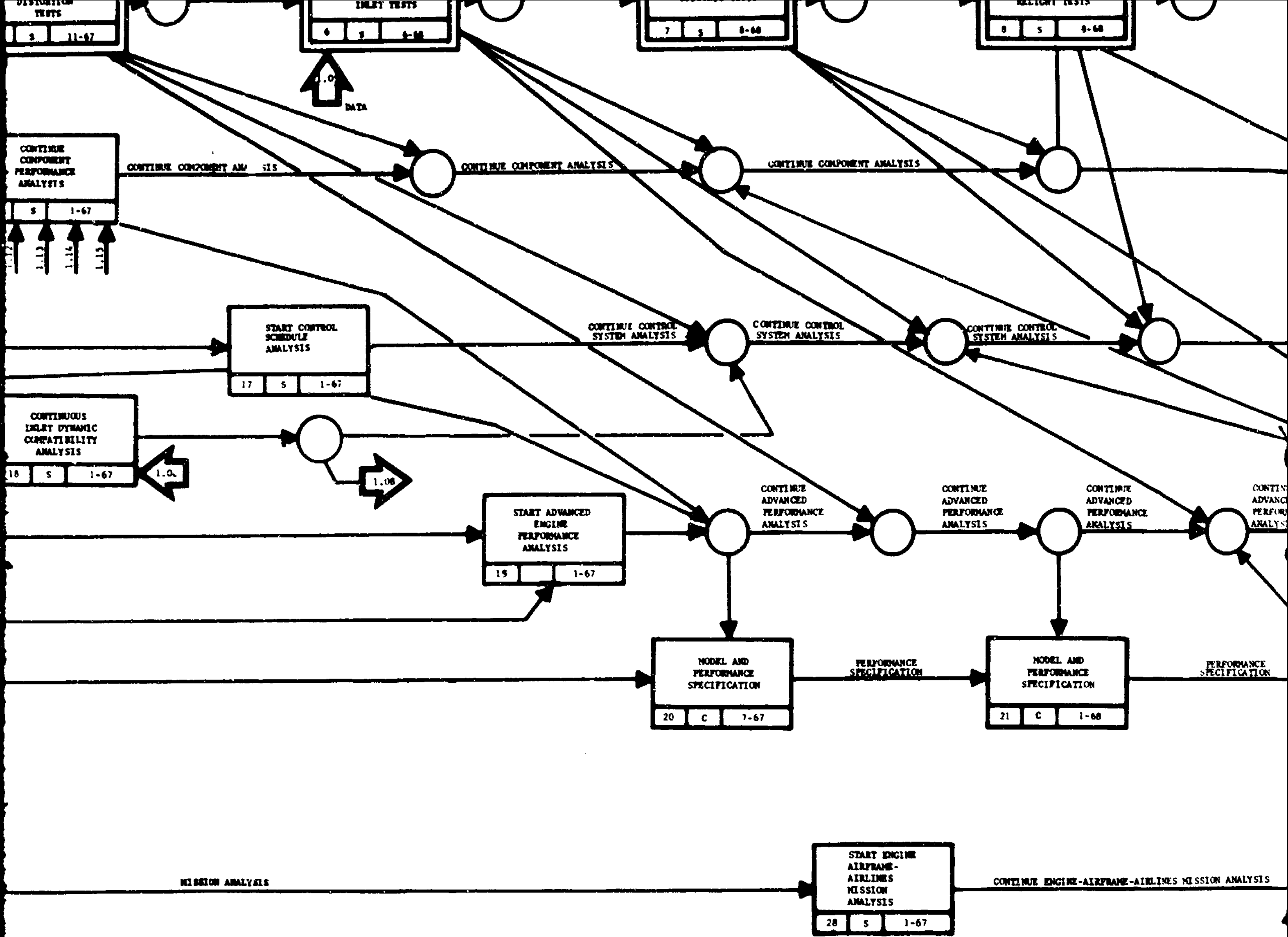


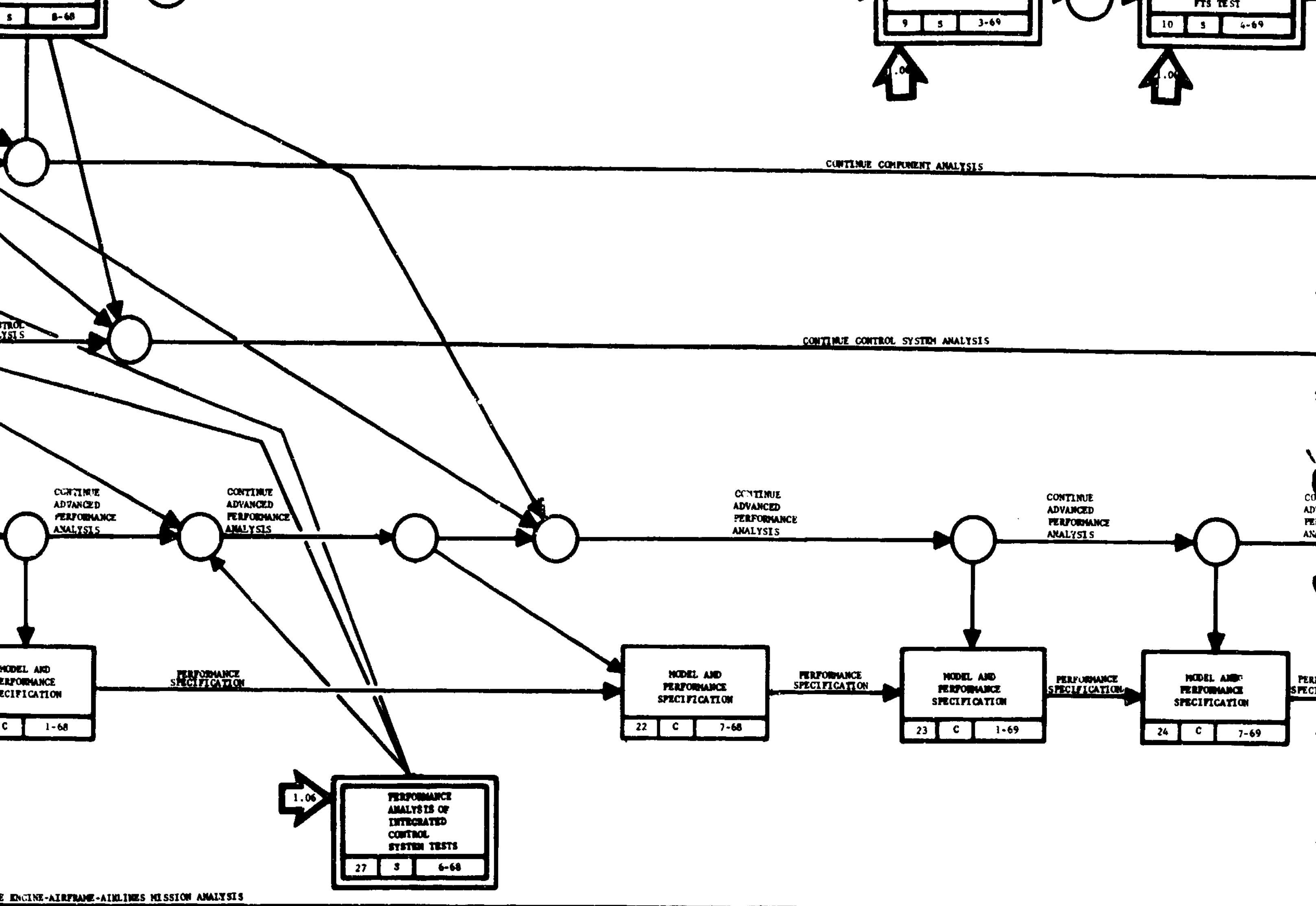
Figure 14. 1.07 Engine Performance



Event Number	Description and Criteria
1	START PHASE III Phase III go-ahead received from FAA.
2	PERFORMANCE ANALYSIS OF REVERSER-SUPPRESSOR TESTS Start analysis of reverser-suppressor test data. Analysis of incoming data is in process.
3	PERFORMANCE ANALYSIS OF AEDC REVERSER-SUPPRESSOR TESTS Start analysis of AEDC reverser-suppressor test data. Analysis of incoming test data is in process.
4	CONTINUE ENGINE PERFORMANCE ANALYSIS Continue analysis of engine test data. Analysis of data is in process.
5	PERFORMANCE ANALYSIS OF INLET DISTORTION TESTS Start analysis of inlet distortion test data. Analysis of data is in process.

Event Number	Description and Criteria
6	PERFORMANCE ANALYSIS OF SIMULATED INLET TESTS Start analysis of data from simulated inlet tests. Analysis of data is in process.
7	PERFORMANCE ANALYSIS OF SUBSONIC TESTS Start analysis of data from subsonic tests. Analysis of data is in process.
8	PERFORMANCE ANALYSIS OF ALTITUDE RELIGHT TESTS Start performance analysis of data from altitude relight tests. Analysis of data is in process.
9	PERFORMANCE ANALYSIS OF FTS PERFORMANCE TEST Start analysis of data from engine FTS test. Analysis of data is in process.
10	PERFORMANCE ANALYSIS OF UNOFFICIAL FTS TEST Start analysis of data from unofficial FTS test. Analysis of data is in process.
11	PERFORMANCE ANALYSIS OF ENGINE FTS TEST Analyze engine FTS test data. Report results of data analysis.

Event Number
12
13
14
15
16
17



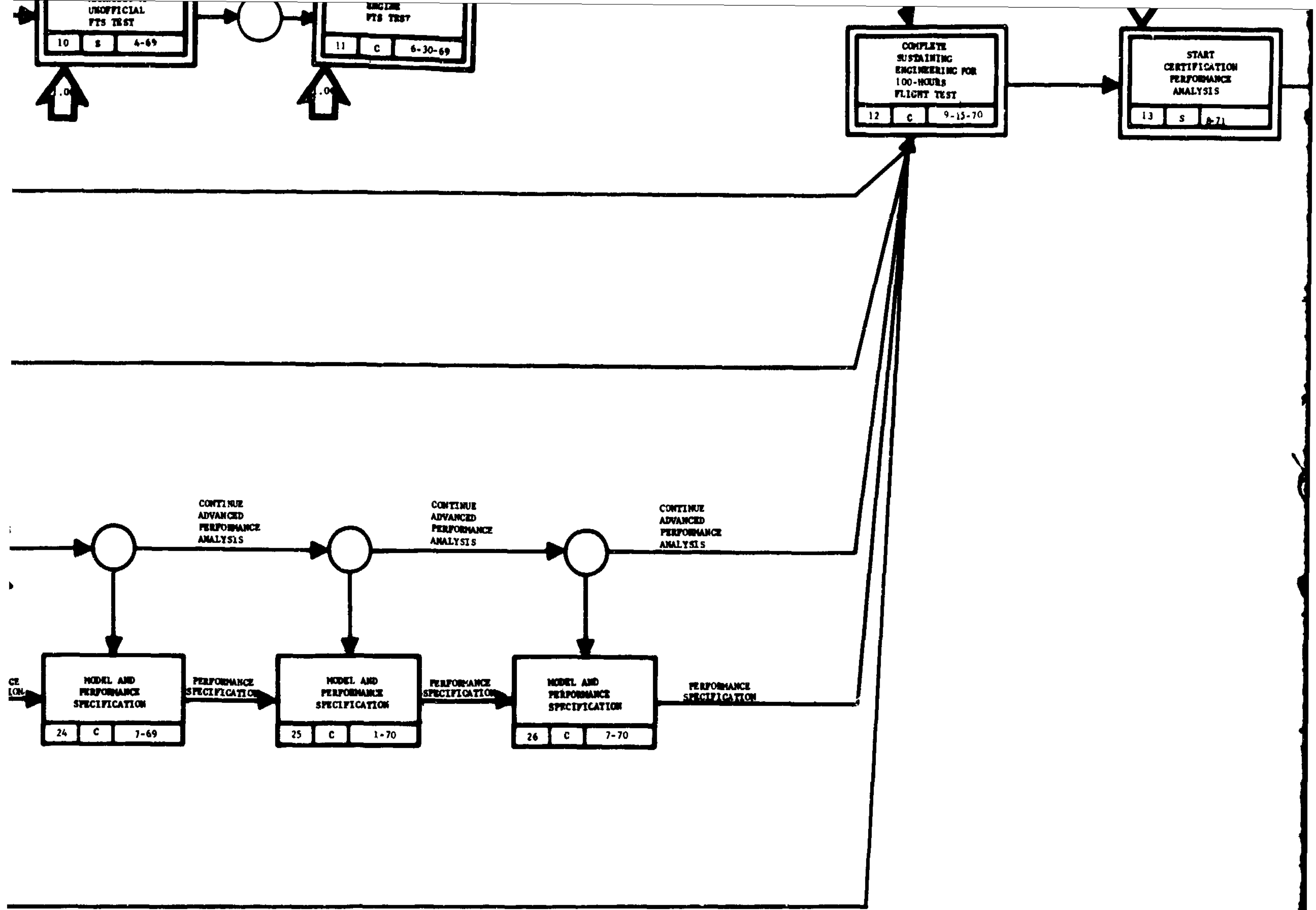
EVENT DICTIONARY
1.07 ENGINE PERFORMANCE

	Event Number	Description and Criteria
ESTS ct	12	COMPLETE SUSTAINING ENGINEERING FOR 100 HOURS FLIGHT TEST End of Phase III. Completion of 100 hours of flight testing.
s.	13	START CERTIFICATION PERFORMANCE ANALYSIS Start analysis of data from Certification performance test. Analysis of data is in process.
TESTS ltitude ocess.	14	UNOFFICIAL CERTIFICATION TEST Reference engine network 1.06 for description and criteria.
EST st.	15	ENGINE CERTIFICATION Reference engine network 1.06 for description and criteria.
ST S test.	16	CONTINUE COMPONENT PERFORMANCE ANALYSIS Continue analysis of component test data. Analysis of component test data is in process.
ults	17	START CONTROL SCHEDULE ANALYSIS Start analysis of control schedules. Analysis of control schedules is in process.

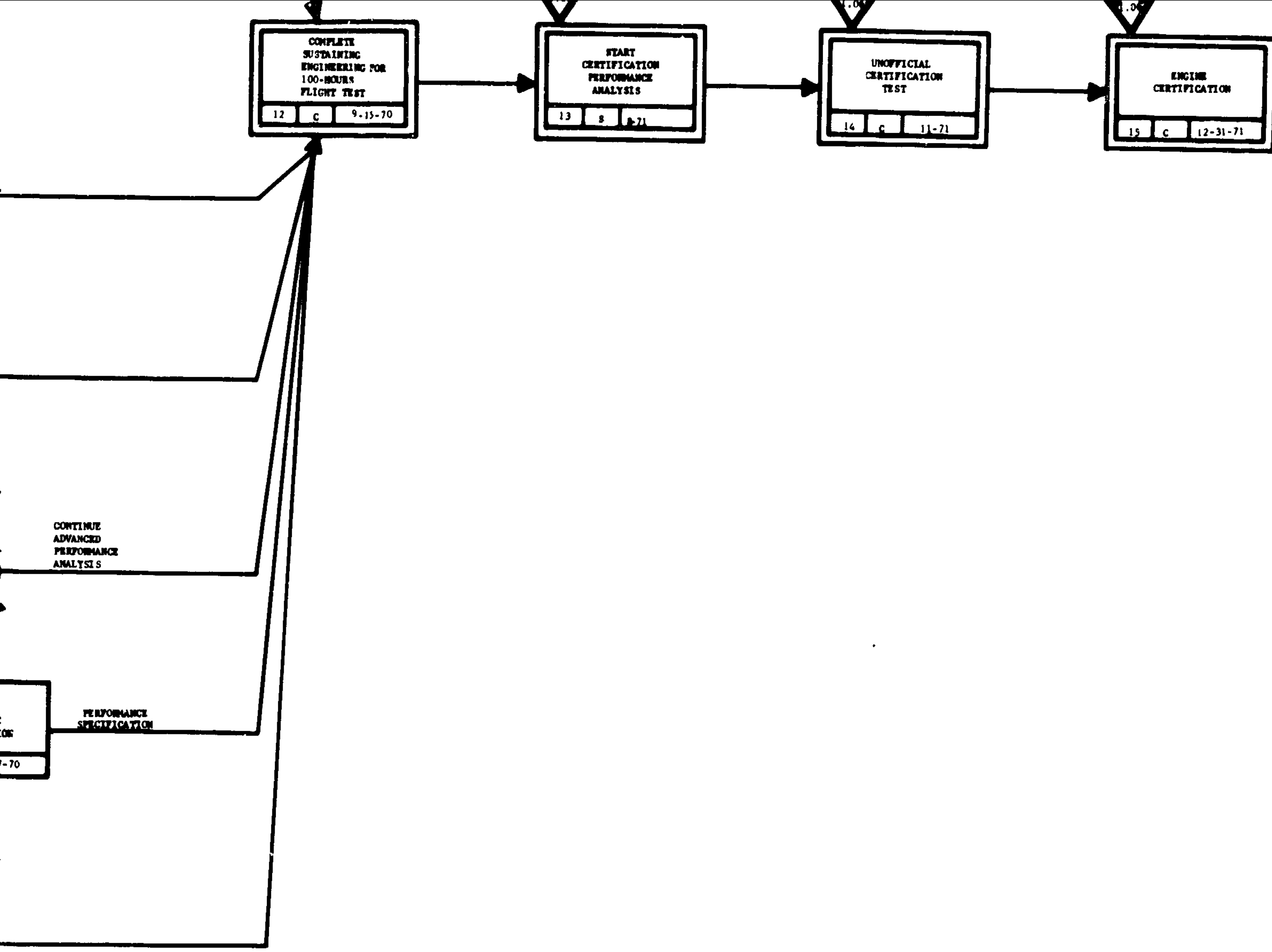
Event Number	Description and Criteria
18	CONTINUOUS INLET DYNAMIC COMPATIBILITY ANALYSIS Start continuing analysis of dynamic compatibility data. Analysis of data is in process.
19	START ADVANCED ENGINE PERFORMANCE ANALYSIS Start analysis of advanced engine performance. Analysis is in process.
20	MODEL AND PERFORMANCE SPECIFICATION Complete update of engine model and performance specification. Issue preliminary specification.
21	MODEL AND PERFORMANCE SPECIFICATION Complete update of engine model and performance specification. Issue preliminary specification.
22	MODEL AND PERFORMANCE SPECIFICATION Complete update of engine model and performance specification. Issue preliminary specification.
23	MODEL AND PERFORMANCE SPECIFICATION Complete update of engine model and performance specification. Issue preliminary specification.

Event Number	
24	MODEL AN Complete specific
25	MODEL AN Complete specific
26	MODEL AN Complete specif
27	PERFORMA SYSTEM TE Start an system t
28	START EN Start ana mission analysis

8



Event Number	Description and Criteria
24	**MODEL AND PERFORMANCE SPECIFICATION** Complete update of engine model performance specification. Issue preliminary specification.
25	**MODEL AND PERFORMANCE SPECIFICATION** Complete update of engine model performance specification. Issue preliminary specification.
26	**MODEL AND PERFORMANCE SPECIFICATION** Complete update of engine model performance specification. Issue firm specification.
27	**PERFORMANCE ANALYSIS OF INTEGRATED CONTROL SYSTEM TESTS** Start analysis of data from integrated control system tests. Analysis of data is in process.
28	**START ENGINE-AIRFRAME-AIRLINES MISSION ANALYSIS** Start analysis of engine-airframe-airlines mission information. Information exchange and analysis in progress.



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1.08 INLET SYSTEM COMPATIBILITY

A closely coordinated effort will be maintained with the airframe manufacturer to make maximum use of all available data affecting the compatibility of the JTF17 engine and inlet with respect to inlet distortion for both steady-state and transient operation. This effort is described in detail in Inlet System Compatibility, Volume III, Report D, Section II. Experience gained on the J58 project and other Pratt & Whitney Aircraft engine high Mach number applications will be directly applied to this program. Inlet steady-state and dynamic characteristics as obtained from the airframe manufacturer will be included in the computer programs. This will be augmented by the data obtained during the engine/inlet compatibility tests conducted by the airframe manufacturer in cooperation with Pratt & Whitney Aircraft.

The airframe manufacturer's inlet model tests will provide an initial indication of the distortion patterns to which the engine will be subjected. These patterns will be duplicated with appropriate screens installed ahead of the P&WA fan rigs. Tests run with these screens will demonstrate the attenuation of this distortion that is provided by the fan. This attenuating characteristic is essential to the development of an engine which will operate surge free and without performance loss with a distorted inlet flow field. In addition to duplicating the inlet model distortion patterns, screens will be constructed to provide additional data of a more general nature on the effects of distortion on fan performance. These data will be used to improve the analytical simulation of distortion effect in our fan and compressor performance prediction systems. A Phase II-C engine will be modified to permit early evaluation of the fan to high compressor interactions. In addition, the fan rigs will be modified to permit a controlled circumferential variation in the engine side discharge flow. This will be used to simulate the distortion attenuating influences of the high compressor. These data will also be used to improve our analytical systems.

A second phase of the fan rig test program will call for testing of a simulated subsonic diffuser of the aircraft inlet duct. This will impose the static pressure gradients produced by the fan on the diffuser and will permit an evaluation of its performance under more realistic operating conditions than were possible during the airframe manufacturer's model tests. This testing is intended to provide early mating of the inlet and compressor in time to permit early corrective action.

Early in the development program, full-scale engine testing will be conducted with distortion screens similar to those described above. These tests will provide a demonstration of the engine's insensitivity to the distortion produced by the inlet. Later tests will incorporate a fully simulated inlet duct. This duct will be used initially to demonstrate satisfactory operation under takeoff and approach conditions.

Refinement of the computer simulation of the engine/inlet system will continue and engine and rig test data will be used to ensure the validity of the simulation. This will be closely coordinated effort by both the engine and the airframe manufacturer. As new inlet model test data are obtained, the inlet simulation will be revised to include significant changes in dynamics or concept. Engine and control test program data will

be used to check the validity of the engine simulation gains and time constant. The computer simulation can then be used concurrently during the test programs to ensure that desired stability and performance requirements are met. This will begin a continuing cycle of test, refinement of simulation, analytical studies and further tests. The program will evaluate phenomena such as the effect of variable gains, deadband, random noise, interaction between the control, engine, and inlet; and interaction between control components for the effects on the overall system. These simulations will also be expanded to reflect efforts of distortion and certain failure modes.

The simulated subsonic diffuser portion of the inlet duct, the boundary layer bleed system, the bypass system and their associated controls will be used to demonstrate dynamic compatibility with the engine during simulated high Mach number operation. These tests will also provide a performance check on any diffuser modifications that may have resulted from earlier rig tests.

The complete propulsion package compatibility demonstration is scheduled to be performed in the AEDC wind tunnel facility at Tullahoma, Tennessee. The details of this program have been negotiated and will continue to be coordinated between Pratt & Whitney Aircraft and the airframe manufacturer. The thorough test evaluation which precedes the AEDC program will minimize any problems which might be associated with the inlet diffuser, the engine, or their control systems. This early development work will materially reduce the cost of the AEDC tests and minimize the time required to provide a compatible propulsion package for flight test.

The major milestones, network chart and event dictionary for inlet system compatibility are shown in figures 15 and 16, respectively.

Test planning and integration of inlet system compatibility is presented in Test, Volume IV, Report E.

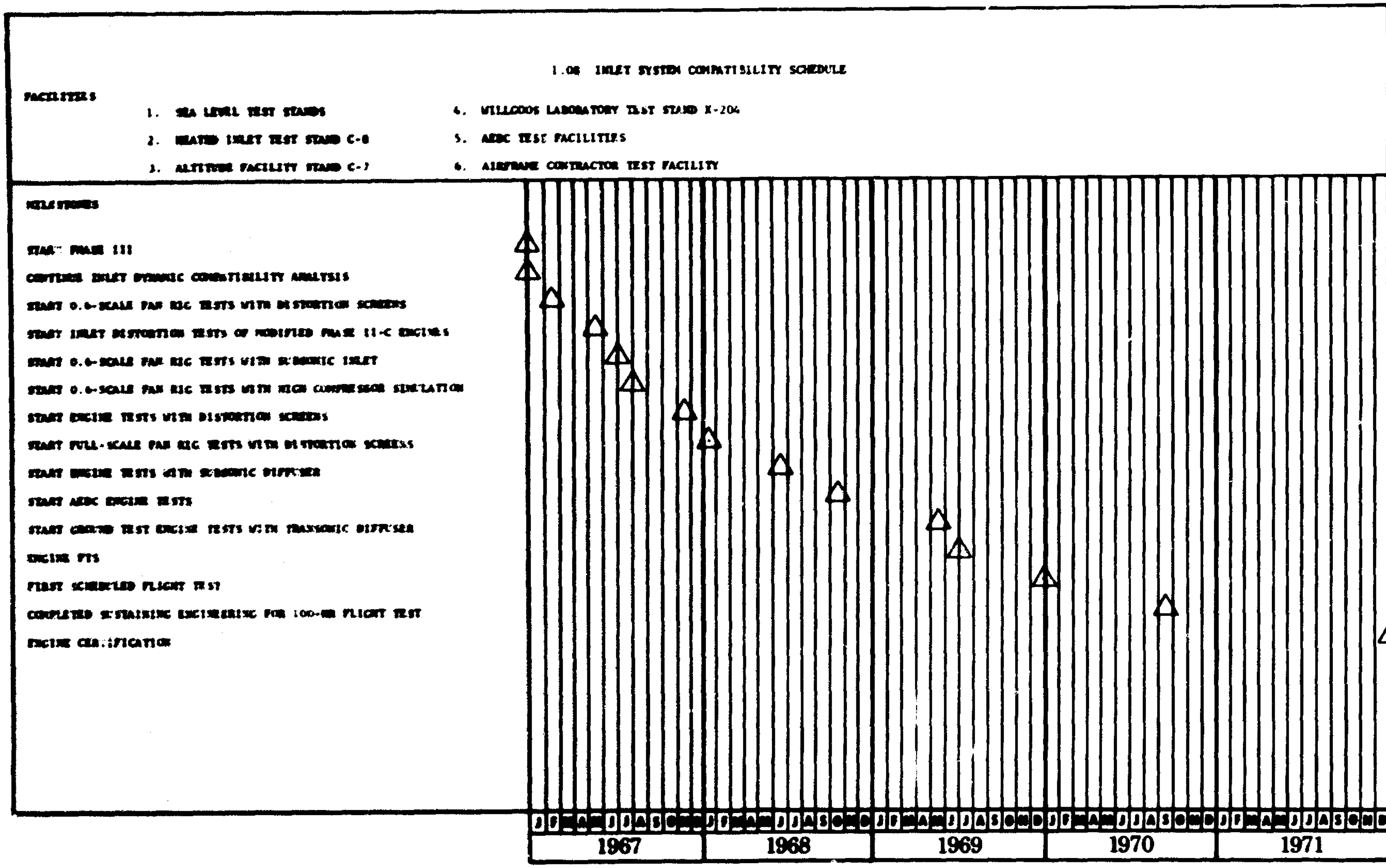

Figure 15. 1.08 Inlet System Compatibility

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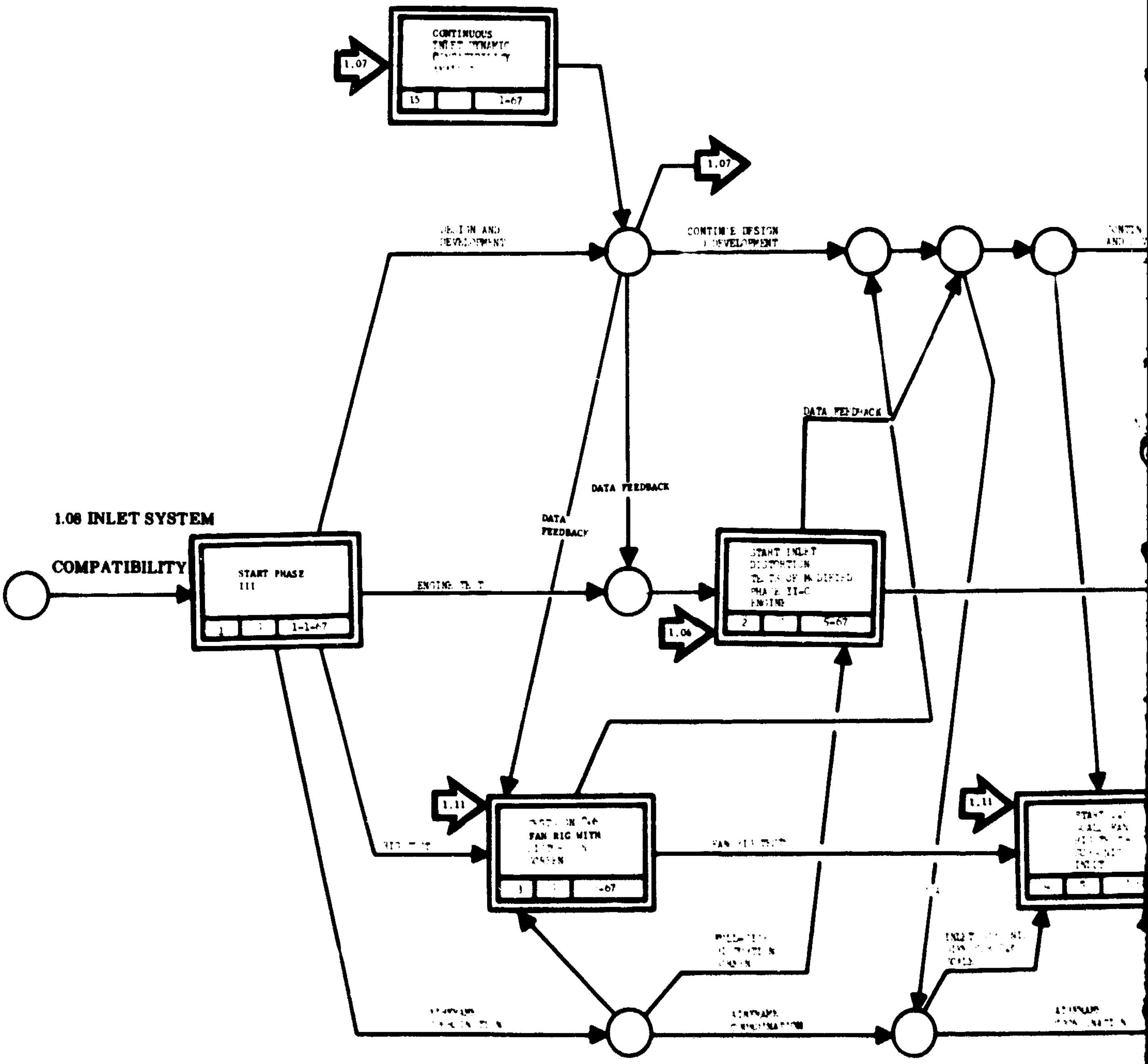
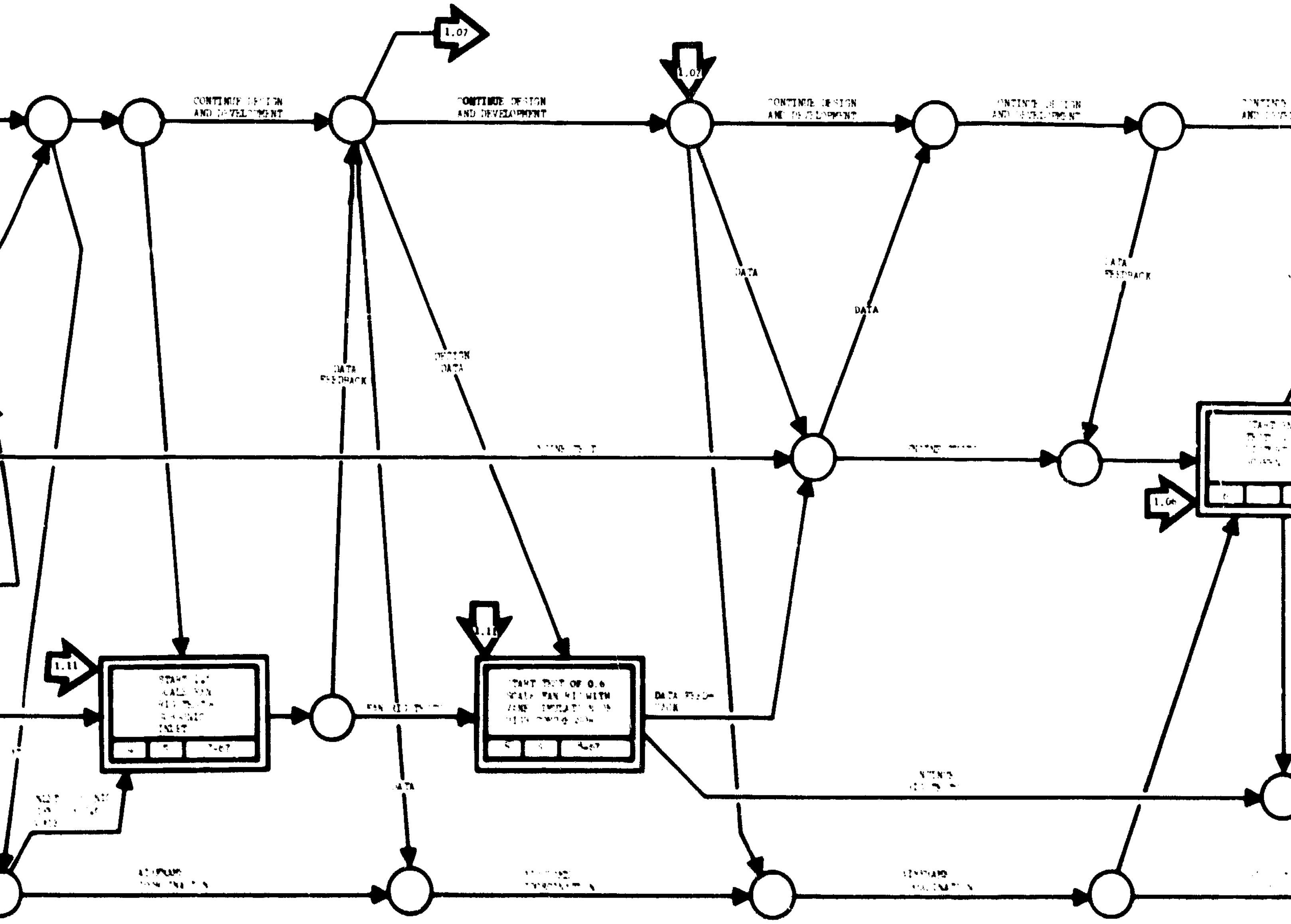


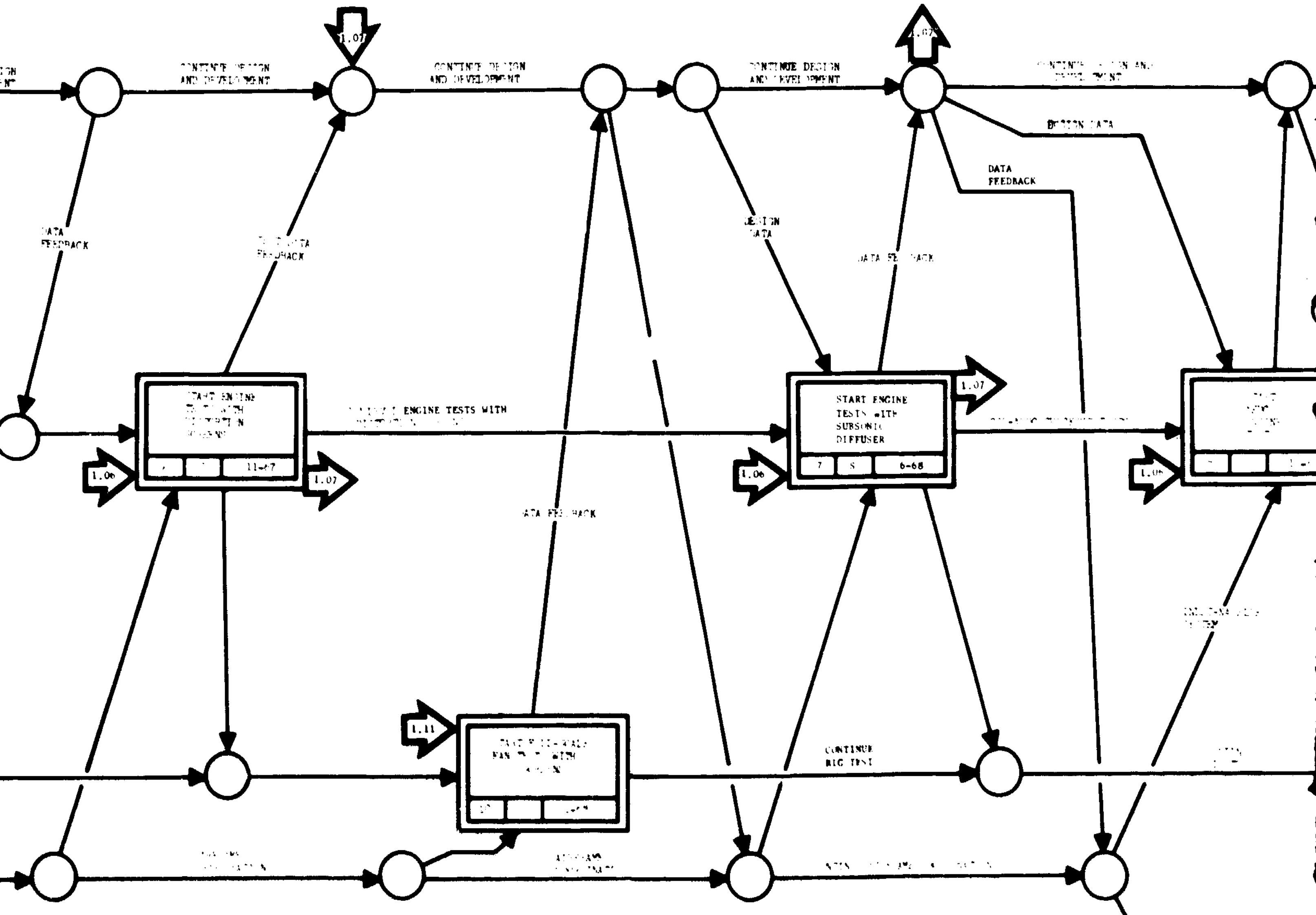
Figure 16. 1.08 Inlet System Compatibility



START PHASE III

2

1.08 Inlet System Compatibility



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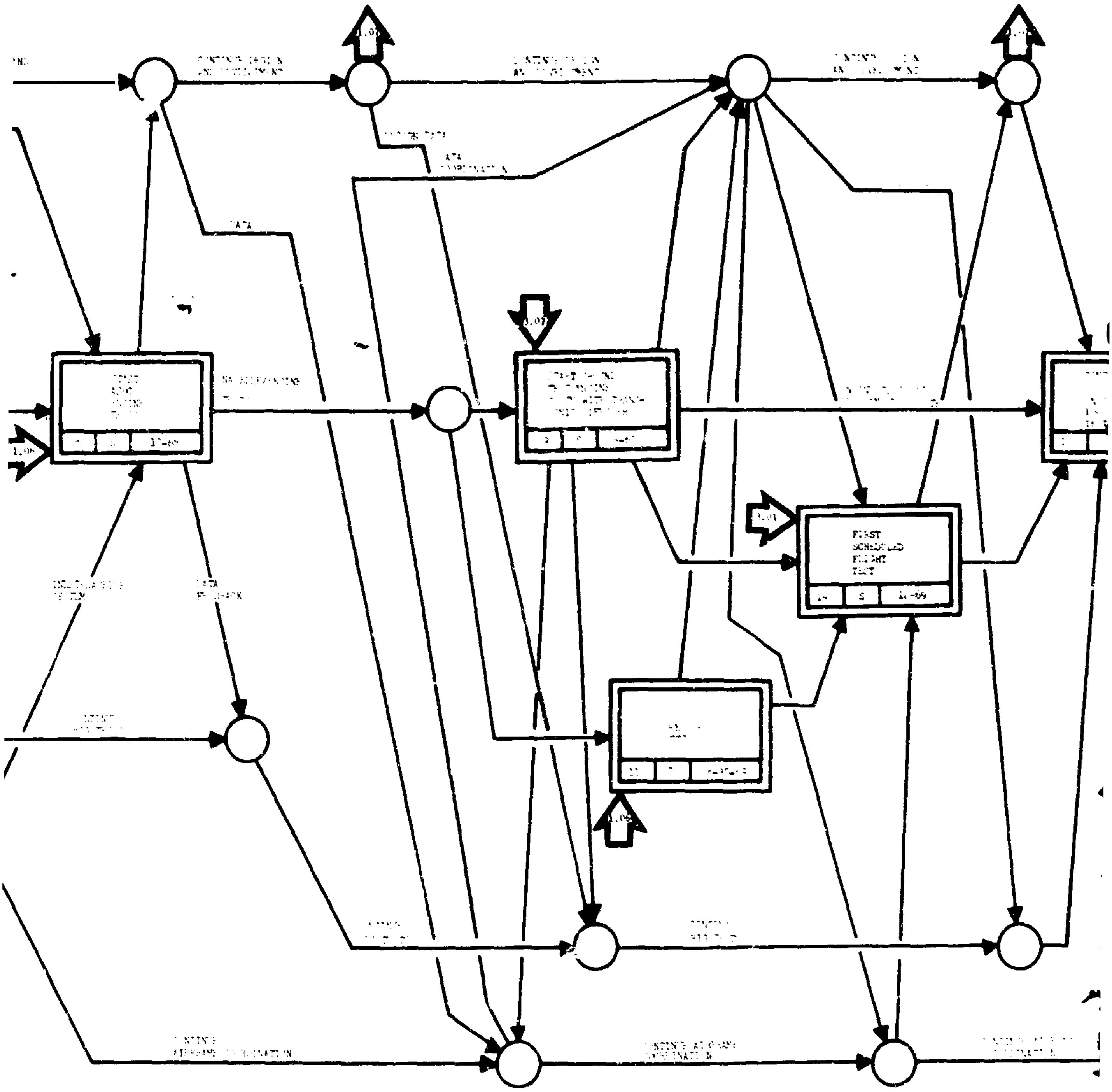

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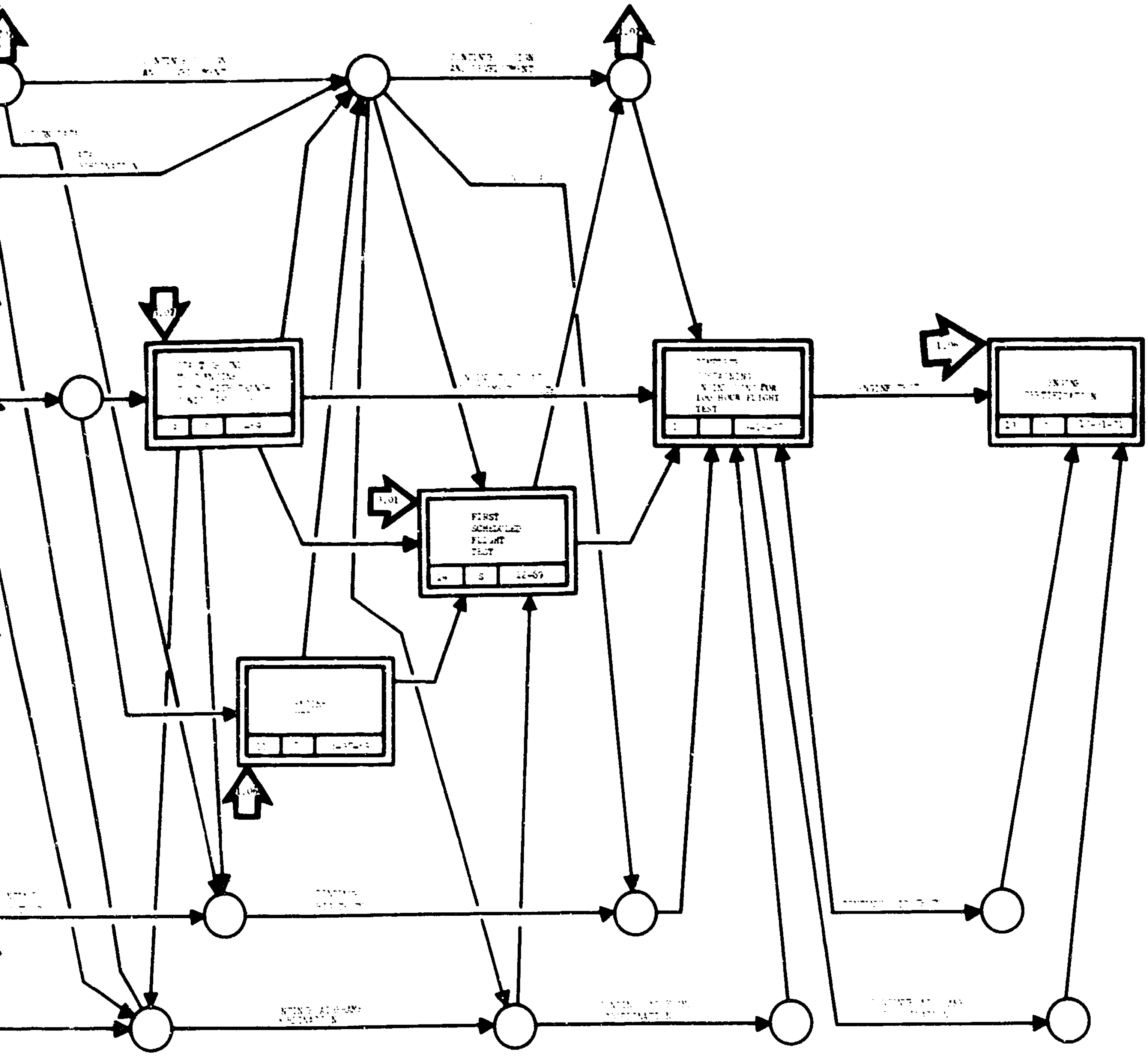

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1.09 NOISE

The JTF17 engine noise suppression program will be directed toward (1) the attenuation of fan noise and (2) the attenuation of exhaust gas noise. The first will pursue methods of fan noise attenuation including fan spacing and application of acoustical liners to the diffuser section of the fan duct. The second will be concerned with methods of exhaust gas noise attenuation and include analyses of the effects of engine nozzle geometry and reverser-suppressor geometry as well as exhaust noise suppressors similar to those in current commercial use.

Analyses of fan noise generation which have been completed by P&WA indicate that the strength of the audible noise is proportional to the pressure differential across the blades and vanes. Reduced pressure differentials can be obtained by such methods and slotted blades and high-lift devices which provide no reduction in the total force acting on the airfoil. Narrow band frequency analyses of resultant effects upon noise will be conducted. Configurations found to be of significant value in rig tests will be evaluated further during full-scale engine tests.

The evaluation of fan noise modifications will begin early in Phase III with an investigation of vane angle effects in the 0.6-scale rig. This work will be performed concurrently with other investigations on the same rig into the effects of blade loading and the generation of combination tone noise. The full-scale compressor rig will be used to determine optimum rotor/stator spacing and vane numbers. An evaluation of the factors which have been found to have an important effect on the generator of combination tones will also be conducted in the full-scale rig.

An evaluation of acoustical liners will begin with impedance tube tests early in Phase III. Both resonant and nonresonant liners will be tested for application in the diffuser section of the fan duct to absorb noise. The results of these tests will be used to select a liner with optimum absorption in the required frequency ranges. The impedance tube tests will be conducted under flow conditions similar to those which exist in the engine fan duct. The results of tests of this type completed during Phase II-C will allow an early evaluation of liners in a JTF17 engine. Fan design modifications resulting from rig tests as well as final development of acoustical liners will be conducted on a development engine. Installed acoustical liner tests will be conducted to:

1. Verify the results of the liner selection program
2. Determine optimum liner locations
3. Measure fan noise transmitted through the fan duct with the liners installed.

Since analytical methods for the evaluation of exhaust system geometry changes on exhaust gas noise do not exist, all development work of exhaust noise suppression devices requires the use of model or full-scale tests. An analysis of the effects of nozzle and ejector geometry upon exhaust gas noise will be conducted on a component model test stand. Tests of exhaust noise suppression devices will be started on this facility at the same time. All model test sound recordings will be subjected to 1/3 octave

band filter analysis and compared to base tests of models without suppression devices. Boilerplate versions of the best configurations from the model tests will then be tested on a JTF17 engine.

In addition to providing a final evaluation of selected suppressor devices, engine tests will be conducted on the noise test stand (A-9) to measure accurately engine noise levels and evaluate available operational techniques. Operational techniques to be evaluated include:

1. The reflection of fan noise upstream during operation of the duct heater at low engine power settings
2. Improved matching of the noise produced by the primary and duct exhaust gases.

Salient features of the noise test stand are:

1. Engine centerline height greater than two nozzle diameters above the ground
2. Clear and level ground extending for a distance of 500 feet from the engine
3. On-site facilities for meteorological measurements
4. Thrust and engine parameter recording capability
5. Permanently located microphone positions
6. Low background noise levels.

The major milestones, network chart and event dictionary for the noise program are shown in figures 17 and 18, respectively.

A detailed description of the noise program is presented in Noise and Suppression, Volume III, Report C, and test integration of the noise program activity is presented in Test, Volume IV, Report E.

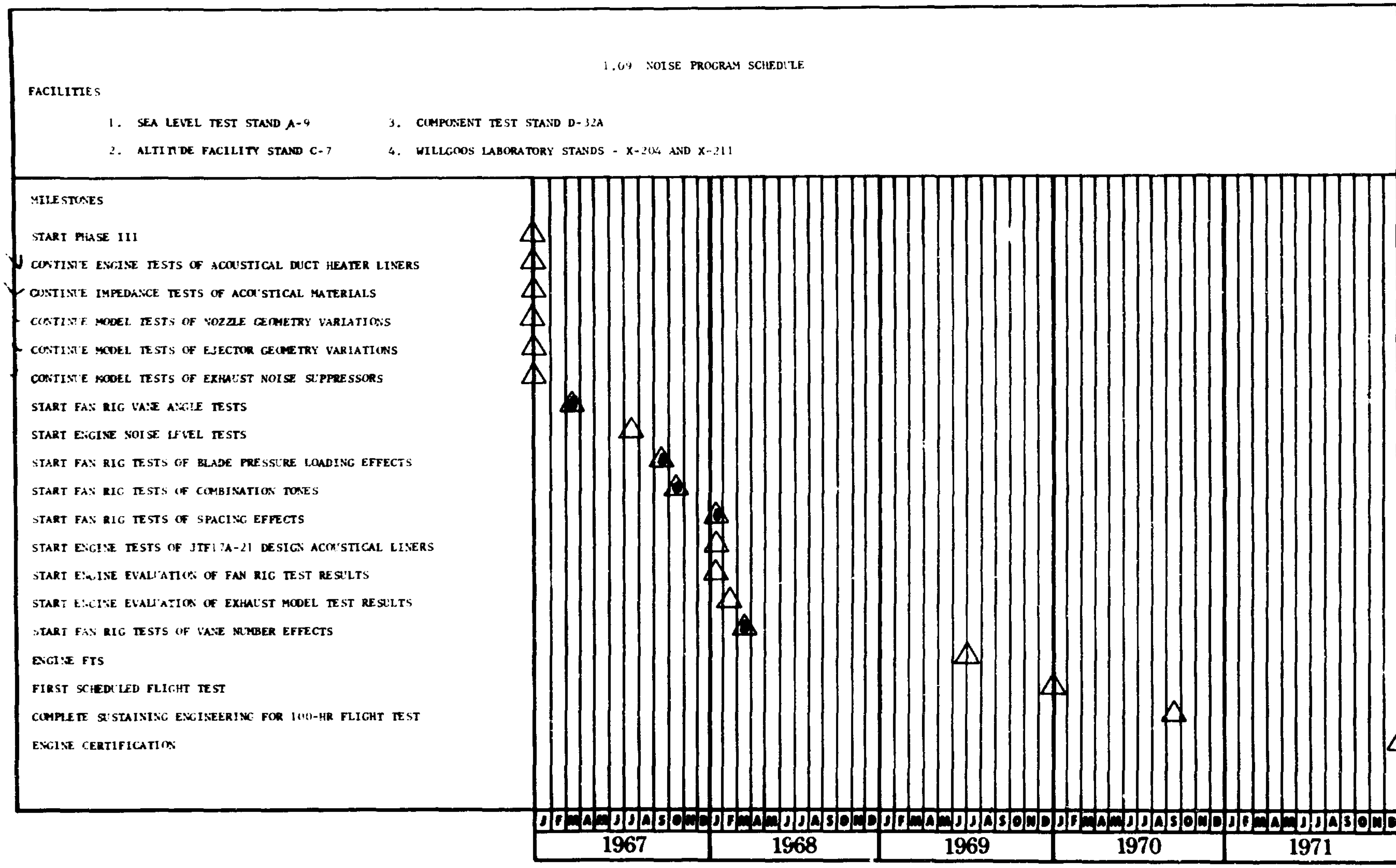

Figure 17. 1.09 Noise

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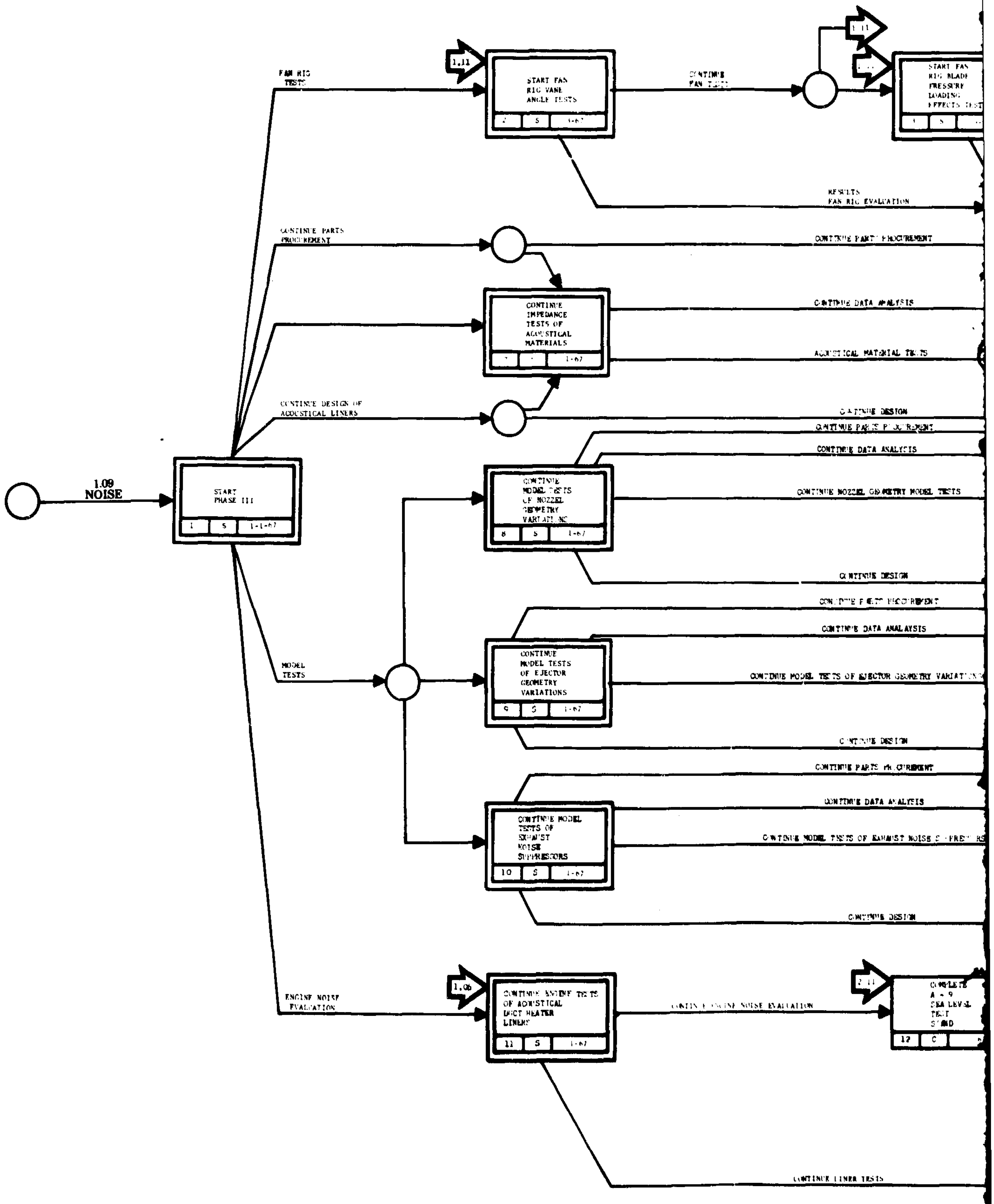
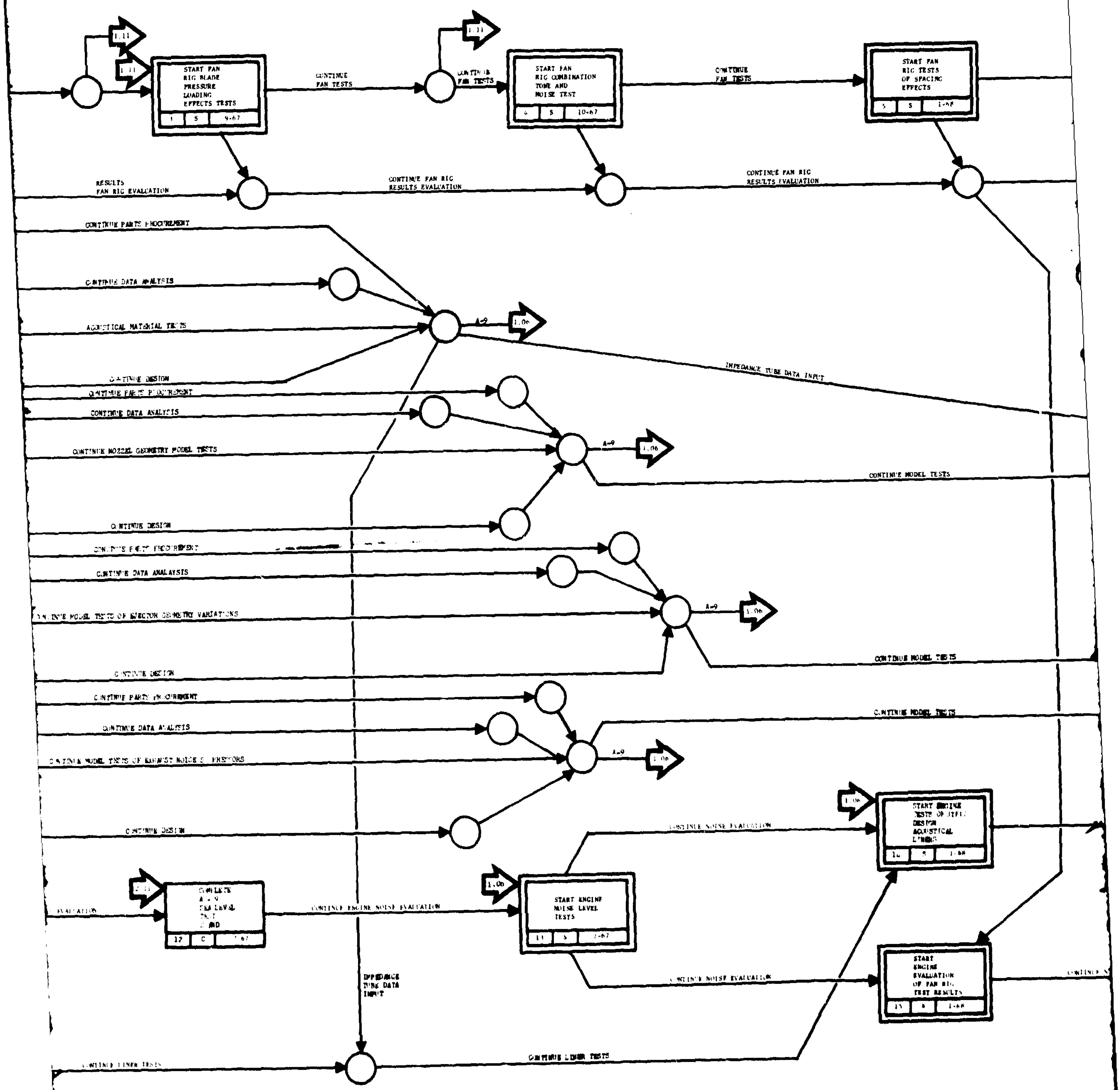


Figure 18. 1.09 Noise



EVENT DICTIONARY

Event Number

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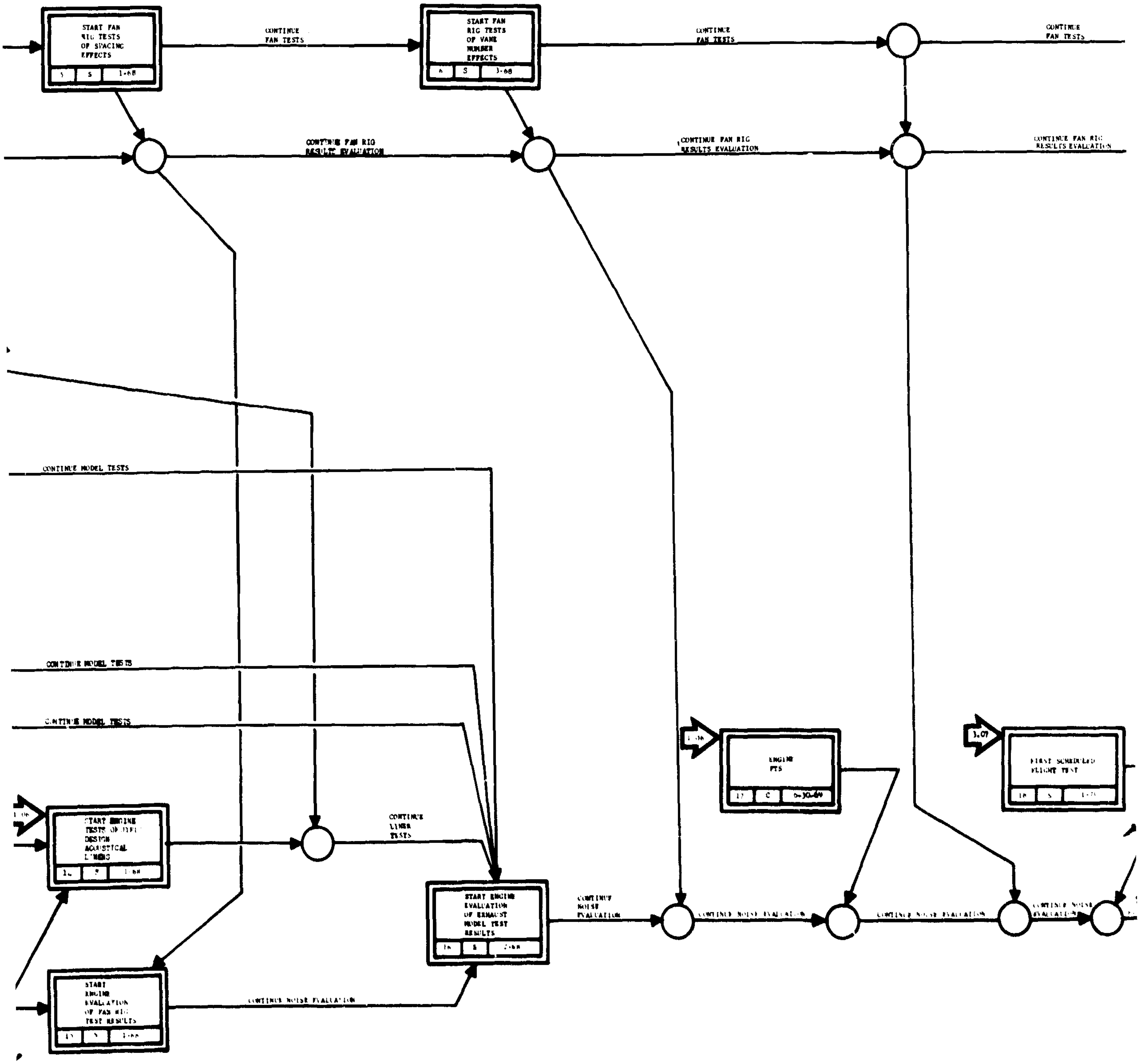
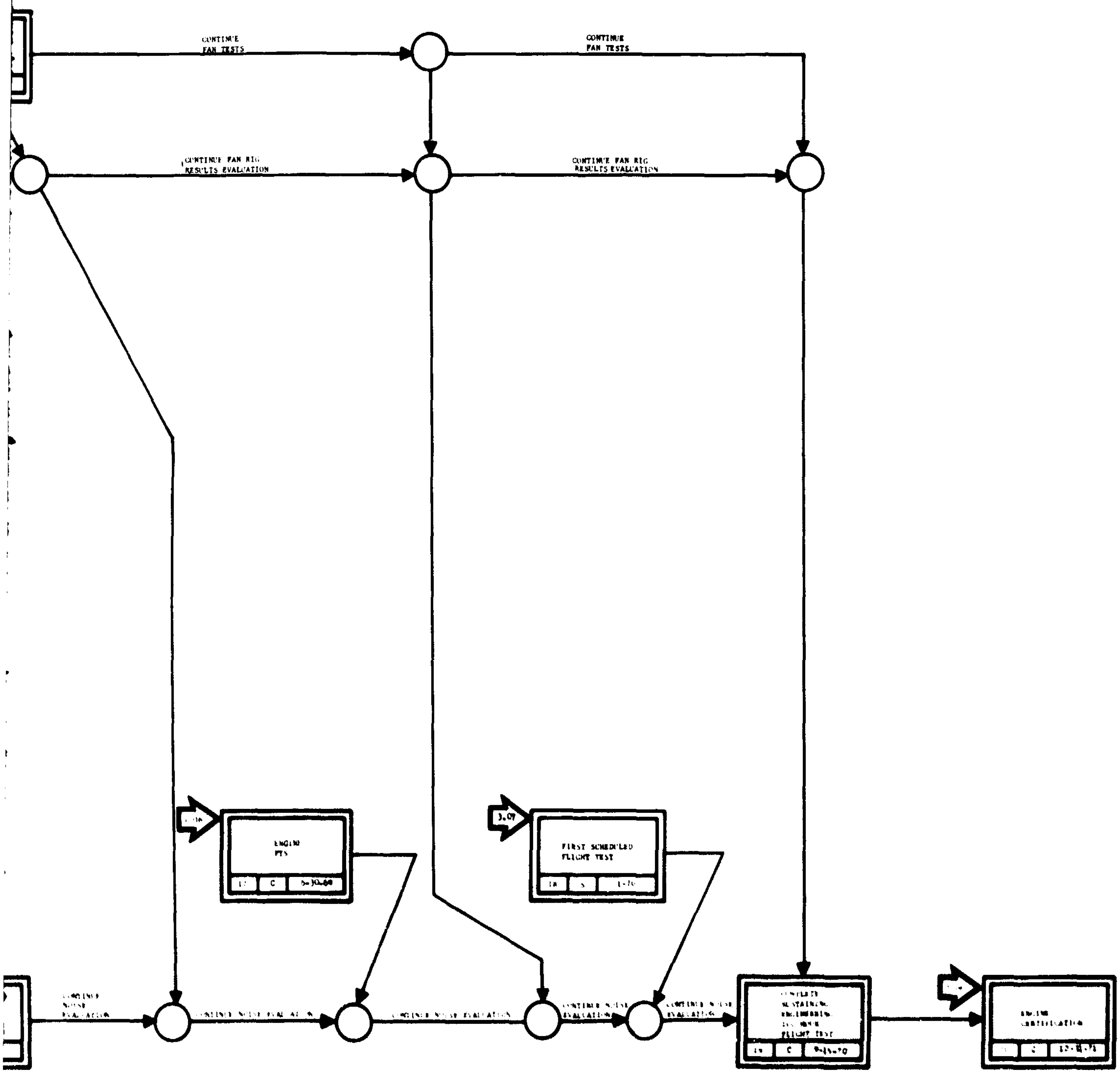

START FAN RIG TESTS OF SPACING EFFECTS
CONTINUE FAN TESTS
START FAN RIG TESTS OF VANE NUMBER EFFECTS
CONTINUE FAN TESTS
CONTINUE FAN TESTS
CONTINUE FAN RIG RESULTS EVALUATION
CONTINUE FAN RIG RESULTS EVALUATION
CONTINUE FAN RIG RESULTS EVALUATION
CONTINUE MODEL TESTS
CONTINUE MODEL TESTS
CONTINUE MODEL TESTS
ENGINE FTS
3.07
FIRST SCHEDULED FLIGHT TEST
START ENGINE
CONTINUE LINER TESTS
START ENGINE EVALUATION OF EXHAUST MODEL TEST RESULTS
CONTINUE NOISE EVALUATION
CONTINUE NOISE EVALUATION
CONTINUE NOISE EVALUATION
CONTINUE NOISE EVALUATION
START ENGINE EVALUATION OF FAN RIG TEST RESULTS
CONTINUE NOISE EVALUATION

3



CONTINUE FAN TESTS
CONTINUE FAN RIG RESULTS EVALUATION
ENGINE PTS
C
3.07
FIRST SCHEDULED FLIGHT TEST
C
ENGINE CERTIFICATION
C

4

1.10 GROWTH POTENTIAL

The growth of the JTF17 engine after introduction to commercial service is directed toward the following improvements:

Improved Performance

Increased takeoff and transonic thrust
Reduced Mach 2.7 cruise TSFC
Reduced noise
Increased operating envelope, particularly to Mach 3 or above

Increased Parts Life and TBO extension

Reduced Specific Weight

During Phase III the JTF17 development effort for growth will be directed toward the above objectives in four major areas:

1. Engine-airframe mission analysis in cooperation with the airframe contractor to direct efforts toward areas of greatest gain for engine growth in terms of airplane economic direct operating cost (DOC) and return on investment (ROI) and reduced noise.

2. Design studies of engine modifications incorporating advanced component performance or features which would improve the JTF17 engine in the growth items listed above.

3. Continued research and advanced development of components for improved performance and noise generation and suppression knowledge.

4. Continued research and advanced development in materials seeking to (a) improve quality and properties of existing materials, (b) develop higher strength-weight alloys for disks and cases, particularly titanium and nickel base alloys, (c) develop coatings for titanium and turbine blades and vanes to inhibit stress-corrosion, oxidation-erosion, and sulfidation.

The major milestones, network chart and event dictionary for growth potential are shown in figures 19 and 20, respectively.

A detailed description of growth potential is presented in Growth, Volume III, Report G.

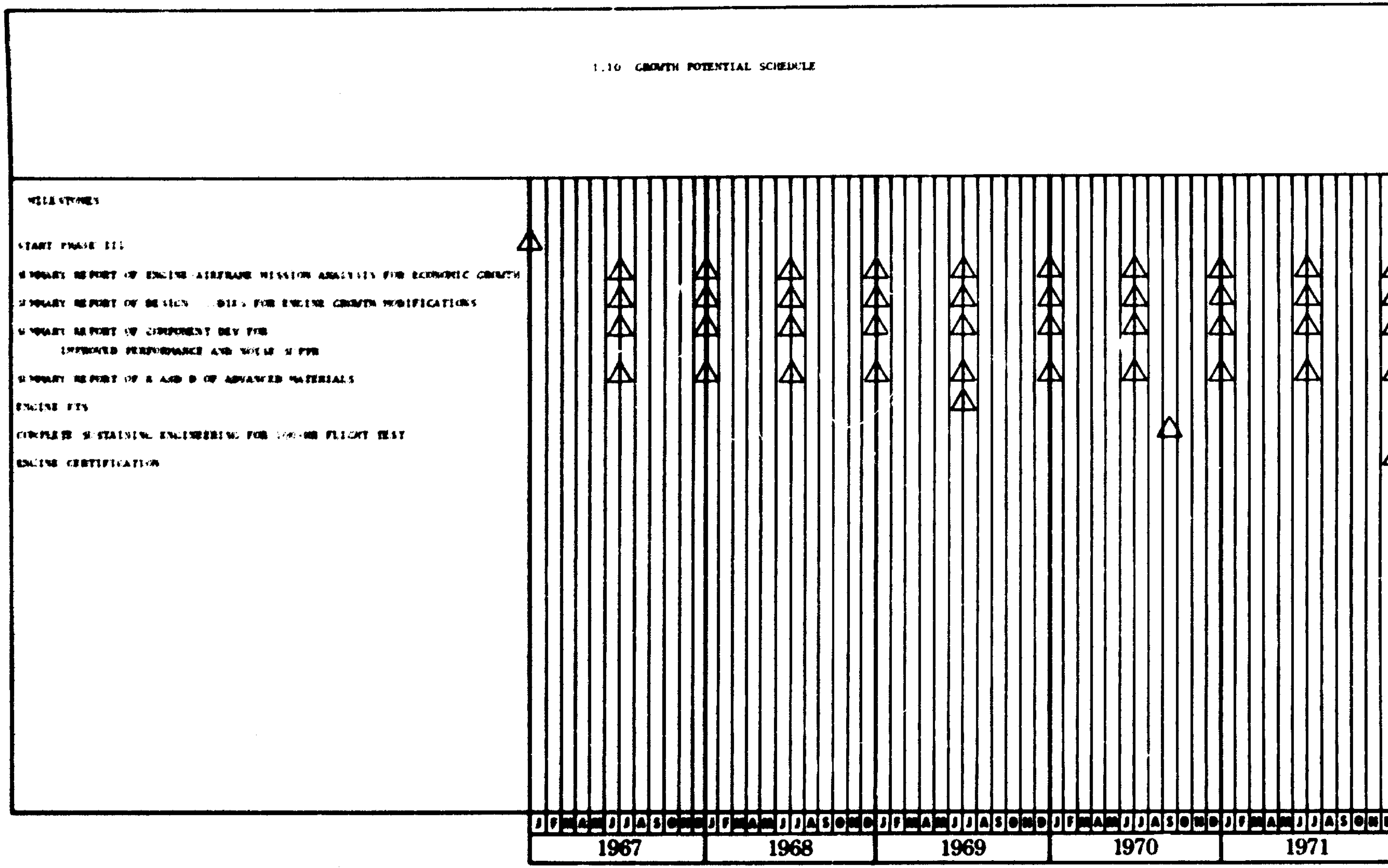


Figure 19. 1.10 Growth Potential

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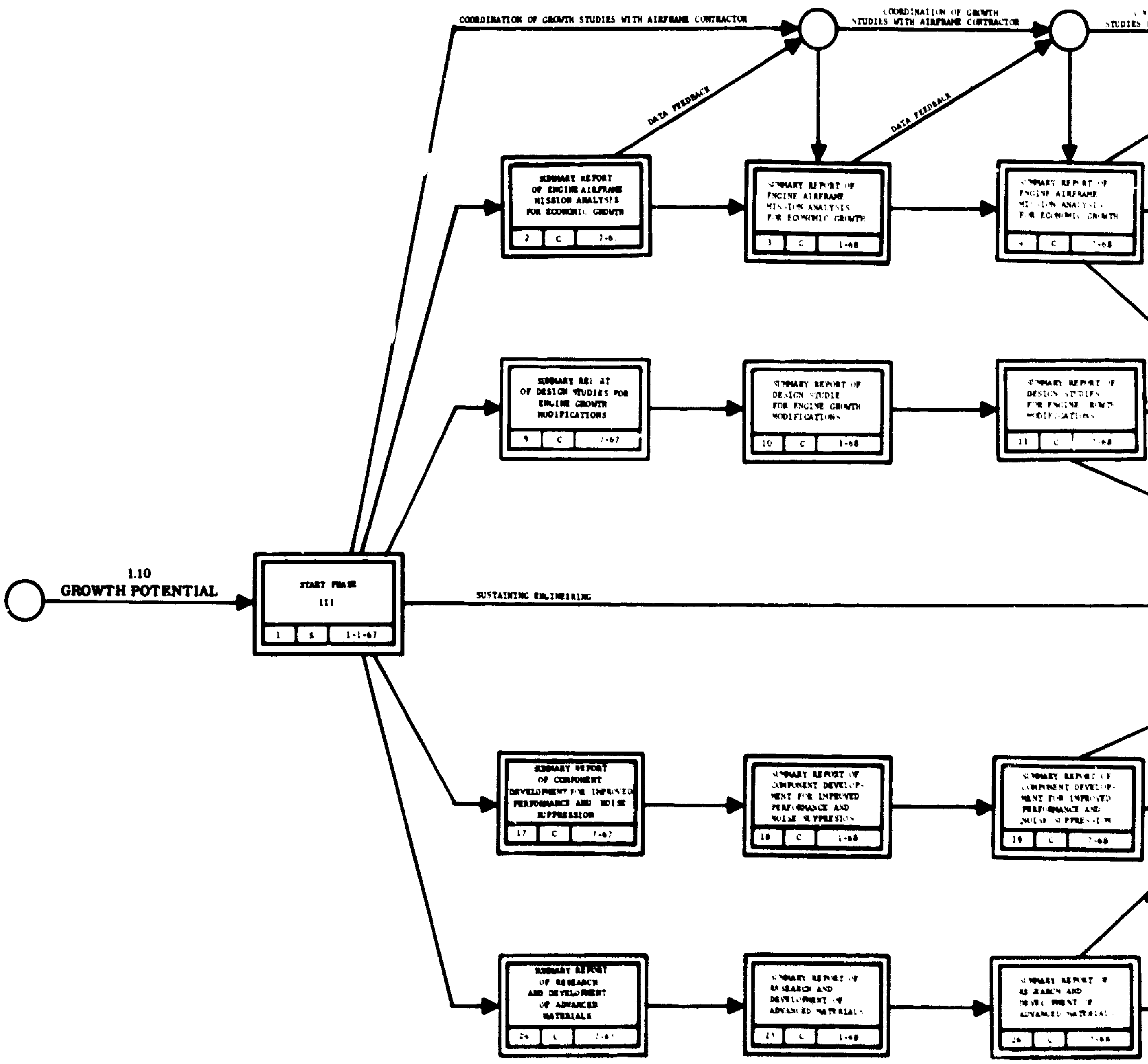
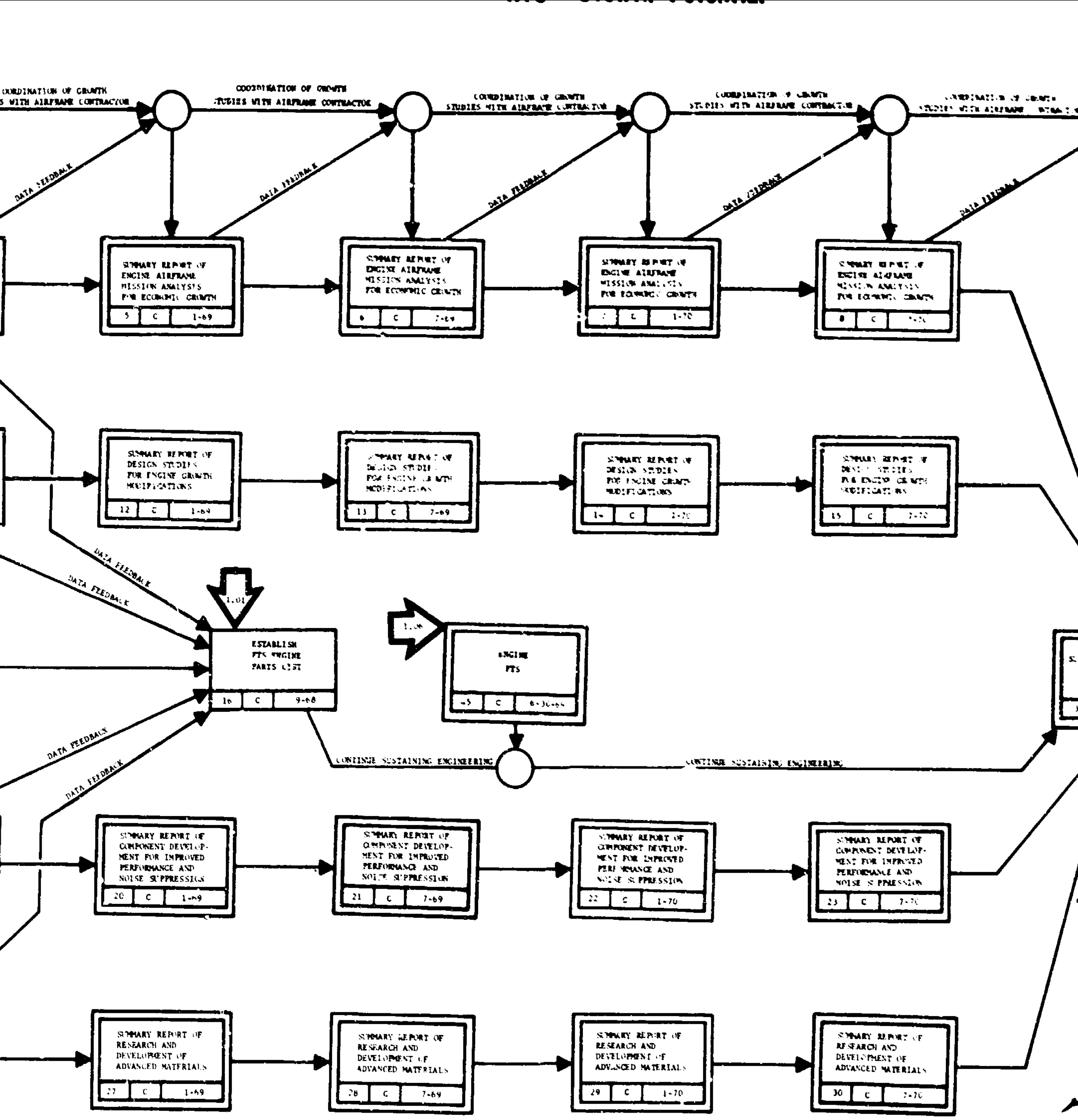


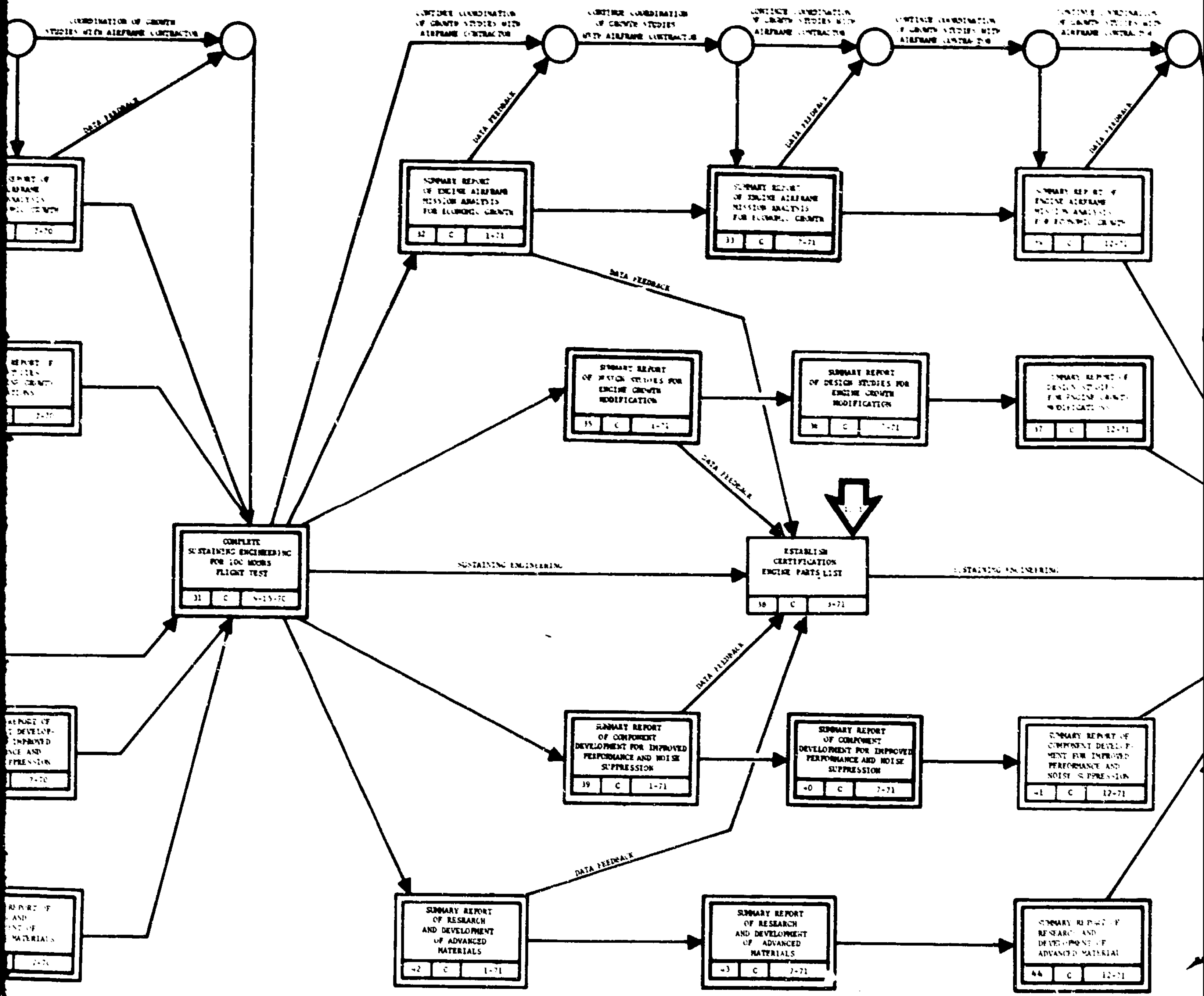
Figure 20. 1.10 Growth Potential



EVENT DICTIONARY
1.10 GROWTH POTENTIAL

Event Number	Description and Criteria
10	**REPORT OF DESIGN STUDIES FOR ENGINE GROWTH MODIFICATIONS** Summarize and prepare report of design studies for engine growth modifications. Issue report.
[illegible]	**REPORT OF DESIGN STUDIES FOR ENGINE GROWTH MODIFICATIONS** Summarize and prepare report of design studies for engine growth modifications. Issue report.
[illegible]	**REPORT OF DESIGN STUDIES FOR ENGINE GROWTH MODIFICATIONS** Summarize and prepare report of design studies for engine growth modifications. Issue report.
[illegible]	**REPORT OF DESIGN STUDIES FOR ENGINE GROWTH MODIFICATIONS** Summarize and prepare report of design studies for engine growth modifications. Issue report.
[illegible]	**REPORT OF DESIGN STUDIES FOR ENGINE GROWTH MODIFICATIONS** Summarize and prepare report of design studies for engine growth modifications. Issue report.
[illegible]	**REPORT OF DESIGN STUDIES FOR ENGINE GROWTH MODIFICATIONS** Summarize and prepare report of design studies for engine growth modifications. Issue report.
[illegible]	**ESTABLISH FTS ENGINE PARTS LIST** Establish a Parts List for the FTS engine design. Release Parts List.
[illegible]	**REPORT OF COMPONENT DEVELOPMENT FOR IMPROVED PERFORMANCE AND NOISE SUPPRESSION** Summarize and prepare report of component development activity for performance improvement and noise suppression. Issue report.
[illegible]	**REPORT OF COMPONENT DEVELOPMENT FOR IMPROVED PERFORMANCE AND NOISE SUPPRESSION** Summarize and prepare report of component development activity for performance improvement and noise suppression. Issue report.
[illegible]	**REPORT OF COMPONENT DEVELOPMENT FOR IMPROVED PERFORMANCE AND NOISE SUPPRESSION** Summarize and prepare report of component development activity for performance improvement and noise suppression. Issue report.
20	**REPORT OF COMPONENT DEVELOPMENT FOR IMPROVED PERFORMANCE AND NOISE SUPPRESSION** Summarize and prepare report of component development activity for performance improvement and noise suppression. Issue report.
[illegible]	**REPORT OF COMPONENT DEVELOPMENT FOR IMPROVED PERFORMANCE AND NOISE SUPPRESSION** Summarize and prepare report of component development activity for performance improvement and noise suppression. Issue report.
22	**REPORT OF COMPONENT DEVELOPMENT FOR IMPROVED PERFORMANCE AND NOISE SUPPRESSION** Summarize and prepare report of component development activity for performance improvement and noise suppression. Issue report.
[illegible]	**REPORT OF COMPONENT DEVELOPMENT FOR IMPROVED PERFORMANCE AND NOISE SUPPRESSION** Summarize and prepare report of component development activity for performance improvement and noise suppression. Issue report.
[illegible]	**REPORT OF R&D OF ADVANCED MATERIALS** Summarize and prepare report of research and development of advanced materials. Issue report.
[illegible]	**REPORT OF R&D OF ADVANCED MATERIALS** Summarize and prepare report of research and development of advanced materials. Issue report.
[illegible]	**REPORT OF R&D ADVANCED MATERIALS** Summarize and prepare report of research and development of advanced materials. Issue report.
[illegible]	**REPORT OF R&D ADVANCED MATERIALS** Summarize and prepare report of research and development of advanced materials. Issue report.

2



Event Number	Description and Criteria
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[illegible]	REPORT OF R&D ADVANCED MATERIALS [illegible]
[illegible]	COMPLETE SUSTAINING ENGINEERING FOR 100 HOURS FLIGHT TEST [illegible] Phase III [illegible]
[illegible]	REPORT OF ENGINE AIRFRAME MISSION ANALYSIS FOR ECONOMIC GROWTH [illegible]
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[illegible]	REPORT OF ENGINE AIRFRAME MISSION ANALYSIS FOR ECONOMIC GROWTH [illegible]
[illegible]	REPORT OF DESIGN STUDIES FOR ENGINE GROWTH MODIFICATIONS [illegible]
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Event Number	Description and Criteria
[illegible]	ESTABLISH CERTIFICATION ENGINE PARTS LIST Establish a Parts List for the certification [illegible] Release Parts List.
[illegible]	REPORT OF COMPONENT DEVELOPMENT FOR IMPROVED PERFORMANCE AND NOISE SUPPRESSION Summarize and prepare report [illegible]
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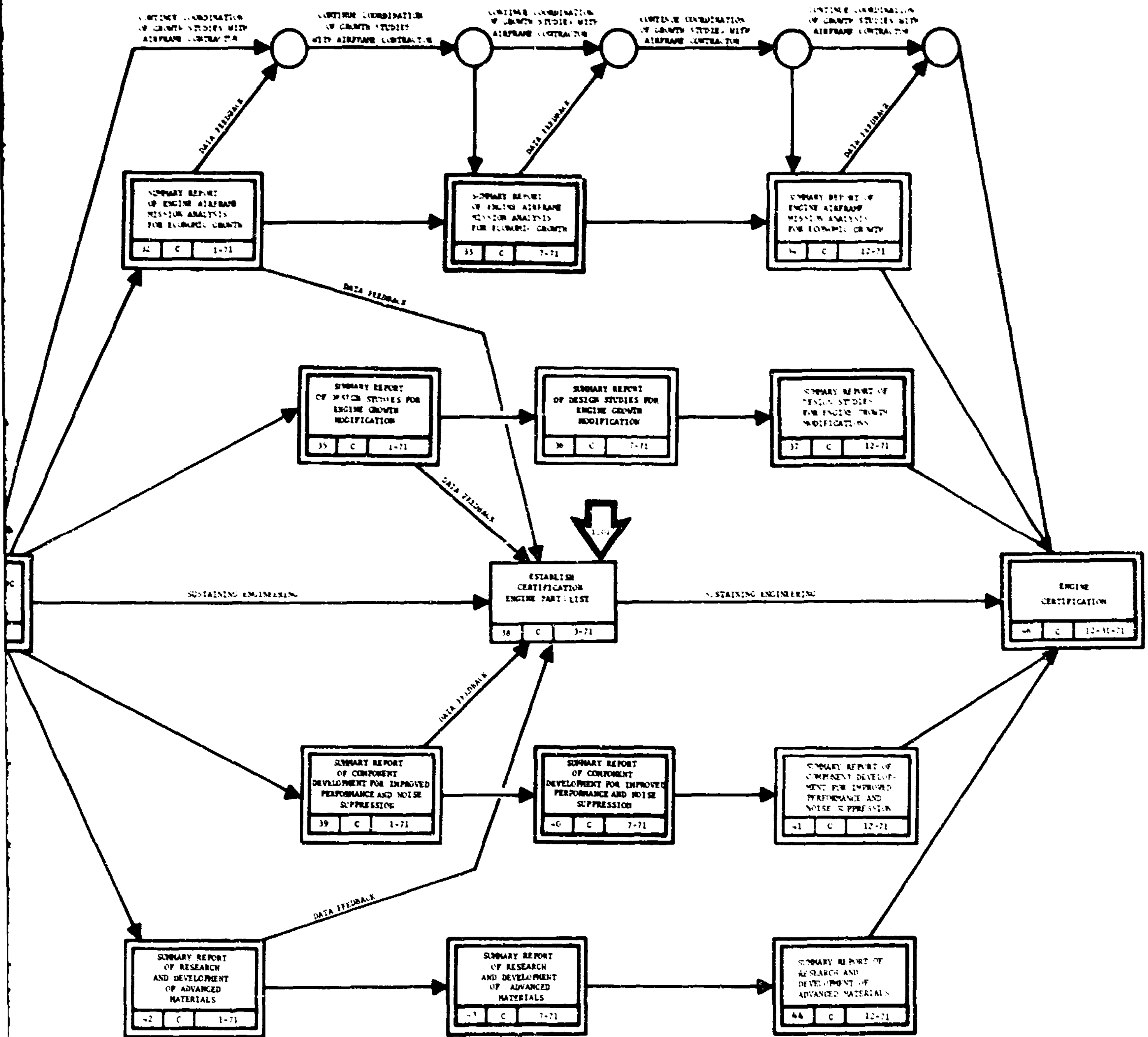

Description and Criteria	Event Number	Description and Criteria
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REPORT OF R&D ADVANCED MATERIAL [illegible]		REPORT OF COMPONENT DEVELOPMENT FOR IMPROVED PERFORMANCE AND NOISE SUPPRESSION [illegible]
[illegible] SUSTAINING ENGINEERING FOR [illegible] TEST [illegible]		REPORT OF COMPONENT DEVELOPMENT FOR IMPROVED PERFORMANCE AND NOISE SUPPRESSION [illegible]
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REPORT OF ENGINE AIRFRAME MISSION ANALYSIS FOR ECONOMIC GROWTH [illegible]		REPORT OF R&D OF ADVANCED MATERIAL [illegible]
REPORT OF ENGINE AIRFRAME MISSION ANALYSIS FOR ECONOMIC GROWTH [illegible]		REPORT OF R&D OF ADVANCED MATERIALS [illegible]
REPORT OF [illegible] FOR ENGINE GROWTH MODIFICATIONS [illegible]		ENGINE FETS [illegible]
REPORT OF [illegible] FOR ENGINE GROWTH MODIFICATION [illegible]		ENGINE CERTIFICATION [illegible] and criteria
REPORT OF [illegible] FOR ENGINE GROWTH MODIFICATIONS [illegible]		

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1.11 FAN AND COMPRESSOR

The 0.6-scale fan rig, used throughout the Phase II-C program, will be rebuilt to the prototype configuration at the initiation of the Phase III development. Initial testing will define the as-designed fan performance of the JTF17 prototype engine and provide the data from which fan development will begin. A second 0.6-scale fan rig will be added to the program to provide the added test effort required for an early start on inlet compatibility testing and noise suppression studies. The details of compressor development aimed primarily at noise attenuation and inlet compatibilitiy are described in Noise and Suppression, Volume III, Report C, and Inlet System Compatibility, Volume III, Report D, Section II.

The scaled rig testing will be replaced by full-scale fan testing when test facilities become available in Phase III. The program will build up to three of the full-scale rigs which utilize engine hardware.

Throughout Phase III the fan rig testing will be utilized to evaluate performance and determine the necessary aerodynamic changes to the blades and stator vanes for performance improvement, and inlet compatibility or noise attenuation as the overall engine development program may require. Frequent tests incorporating strain gage instrumentation will reveal any resonant or aerodynamic vibration problems associated with the fan so that correction can be made before they develop into engine problems. The fan program will include fan rig tests at heated inlet conditions to ensure that the fan is free of aeroelastic stress or mechanical vibration problems under all operating conditions.

The high compressor program will utilize three full-scale compressor test rigs which duplicate the aerodynamic and structural configurations of the engine compressor. As with the fan the first testing accomplished early in Phase III will define the performance of the prototype high compressor and provide the data from which the high compressor development can begin. Continuing from Phase II-C, the high compressor rig program will evaluate and develop overall compressor performance as necessary to meet engine goals. All stages of the compressor will be strain gaged to monitor and record any significant vibration stresses attributable to natural resonance of the parts, or aerodynamic excitation. This testing will include heated inlet running to determine the effects of high Mach number operation on performance and stress.

To provide the extended low cycle disk life necessary for the supersonic transport, the design of the high compressor incorporates features to reduce disk thermal stresses during transient operations to and from high Mach number operation. The high compressor rig will be assembled with disk temperature instrumentation to evaluate the effectiveness of the disk cooling scheme.

Compressor and fan rig testing cannot be considered as meaningful as engine endurance testing to develop the durability of the compressor. However, the repeated surges and off-design operation of these rigs is in some respect more severe than engine endurance and will provide excellent substantiation of blade shroud designs as well as general airfoil and disk designs.

The compressor rig and engine test program will be supplemented by an extensive materials evaluation and development program. The details of this program, which will include high and low cycle fatigue, stress rupture and extended creep testing of compressor materials, are contained in Manufacturing Techniques and Materials, Volume III, Report F. The fan and high compressor sections of the JTF17 engine are designed to provide blade containment so that a possible blade failure will be contained to prevent external damage. Because compressor rig testing and early operation of the prototype engines will undoubtedly result in off-design operation, the probability of a fan or compressor blade failure will be high. Any such failure will of course be fully analyzed for the cause of failure; in addition, the compressor case containment will be evaluated and the design revised if necessary. A 1st-stage fan blade will be intentionally failed in a spin pit test to verify the containment of the fan section since this represents the most severe containment requirement of the engine.

The major milestones, network chart and event dictionary for the fan and compressor are shown in figures 21 and 22, respectively.

A detailed description of fan and compressor development is presented in the Test and Certification Plan, Volume III, Report E, and test planning and integration is presented in Test, Volume IV, Report E.

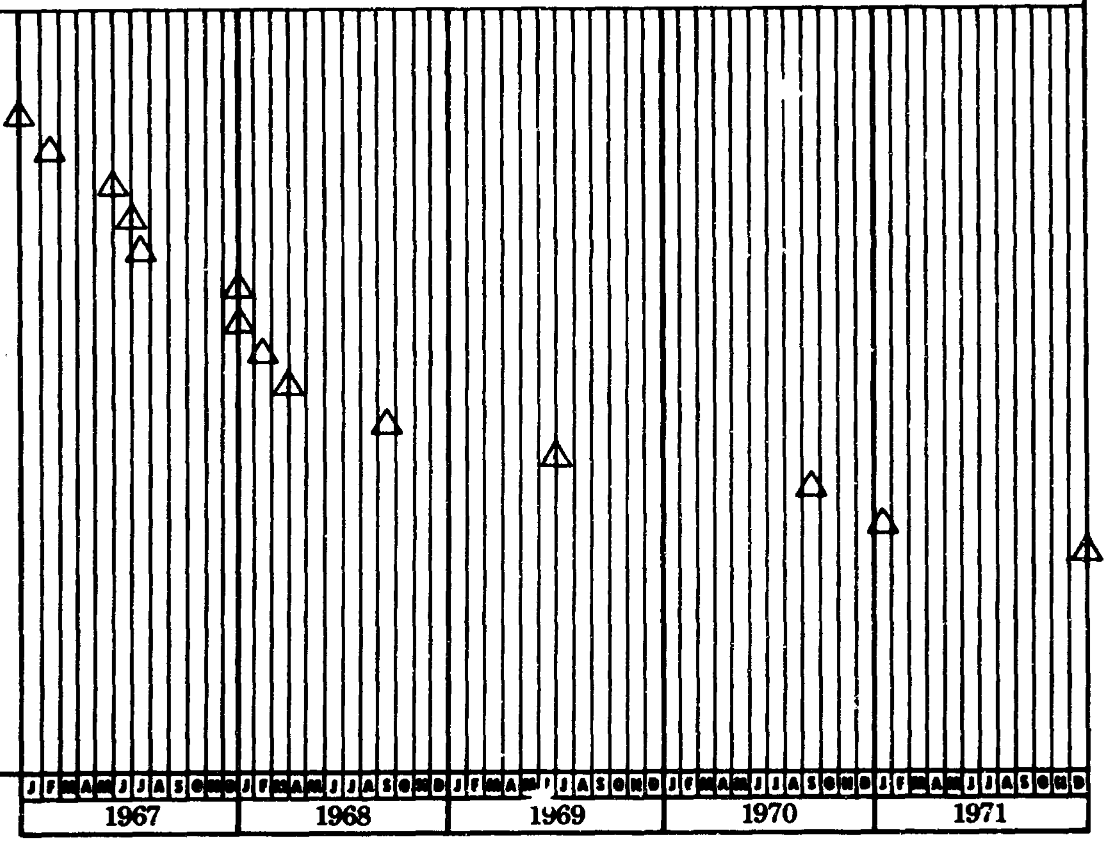
1.11 FAN DEVELOPMENT SCHEDULE

FACILITIES

1. ALTITUDE FACILITY STAND C-7
2. WILLGOOS LABORATORY STANDS - X-204, X-211, and X-17

MILESTONES

- COMPLETED PHASE II-C RIG TESTING
- START PHASE III
- START TESTS OF 0.6-SCALE FAN RIG
- START TESTS OF SECOND 0.6-SCALE FAN RIG
- START INLET DUCT TESTS WITH 0.6-SCALE FAN RIG
- COMPLETE FULL-SCALE FAN RIG DESIGN
- START FULL-SCALE FAN RIG TESTS
- START NOISE TESTS OF FULL-SCALE FAN RIG
- START TESTS OF SECOND FULL-SCALE FAN RIG
- START TESTS OF THIRD FULL-SCALE FAN RIG
- SELECT FAN FTS CONFIGURATION
- ENGINE FTS
- COMPLETE SUSTAINING ENGINEERING FOR 100-HR FLIGHT TEST
- SELECT CERTIFICATION CONFIGURATION
- ENGINE CERTIFICATION



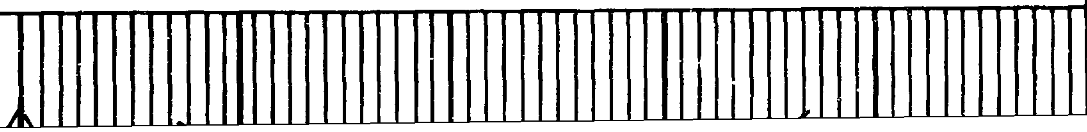
1.11 HIGH COMPRESSOR DEVELOPMENT SCHEDULE

FACILITIES

ALTITUDE FACILITY STANDS - C-3 AND C-7

MILESTONES

- COMPLETED PHASE II-C RIG TESTING
- START PHASE III



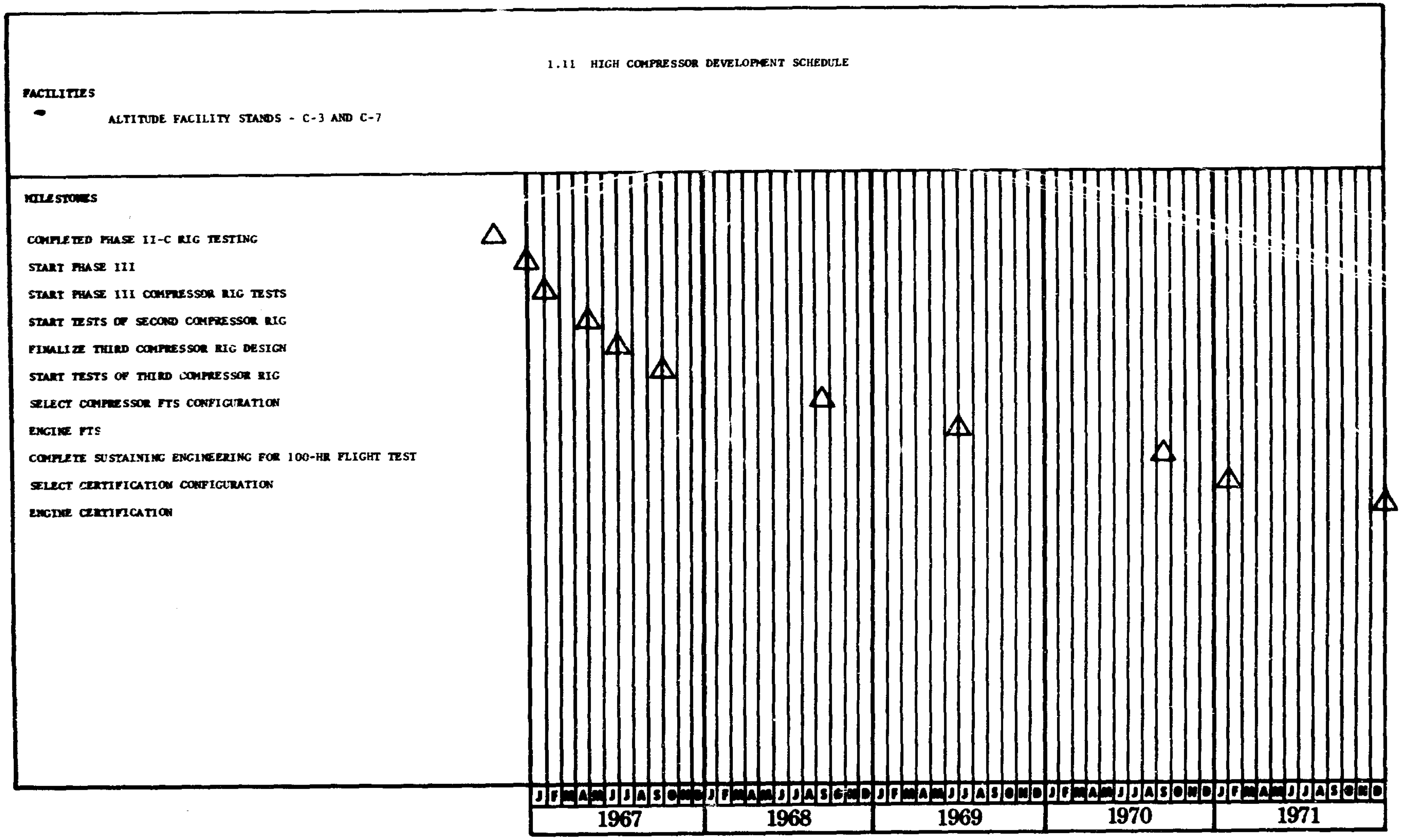


Figure 21. 1.11 Fan and Compressor

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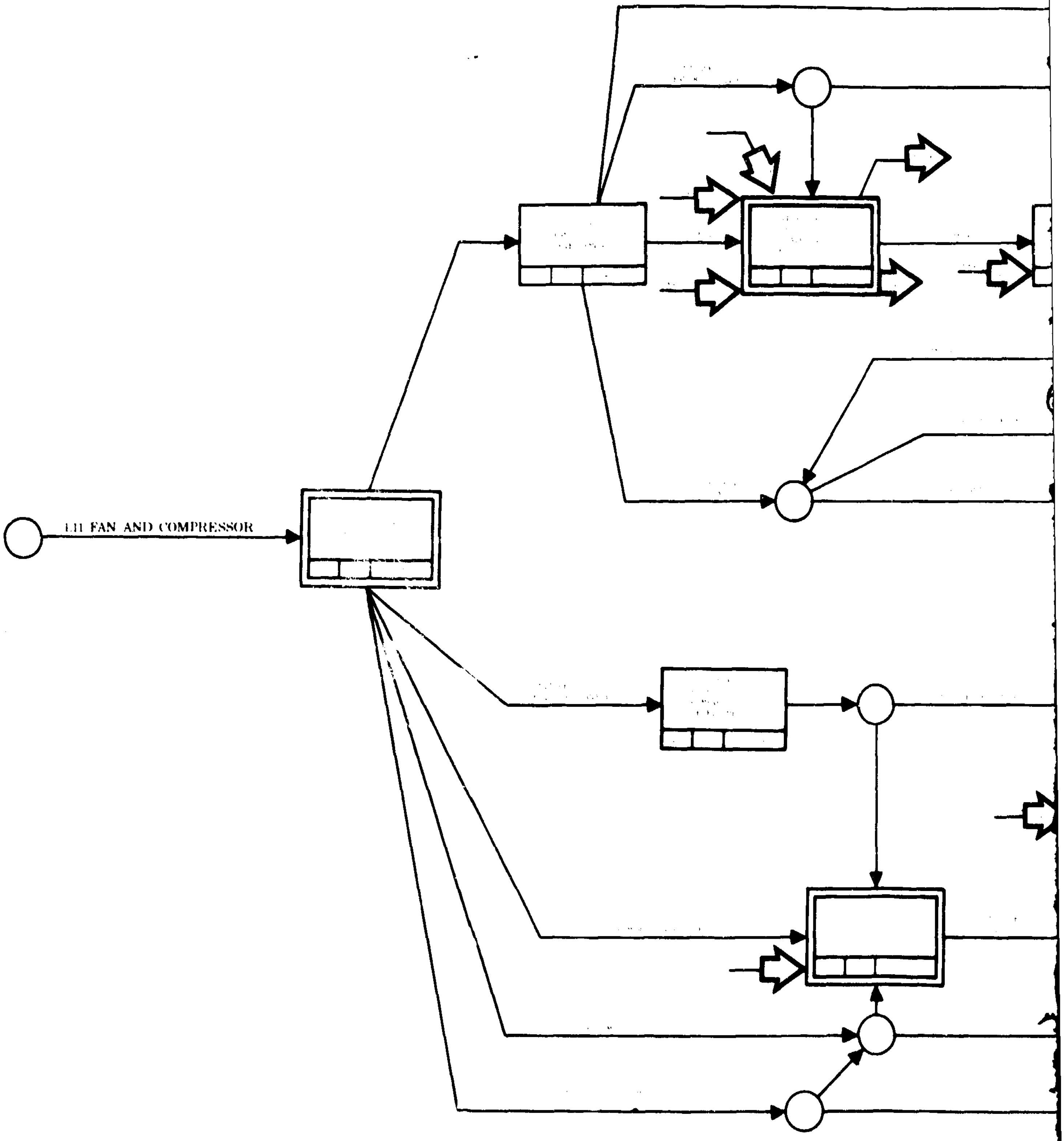
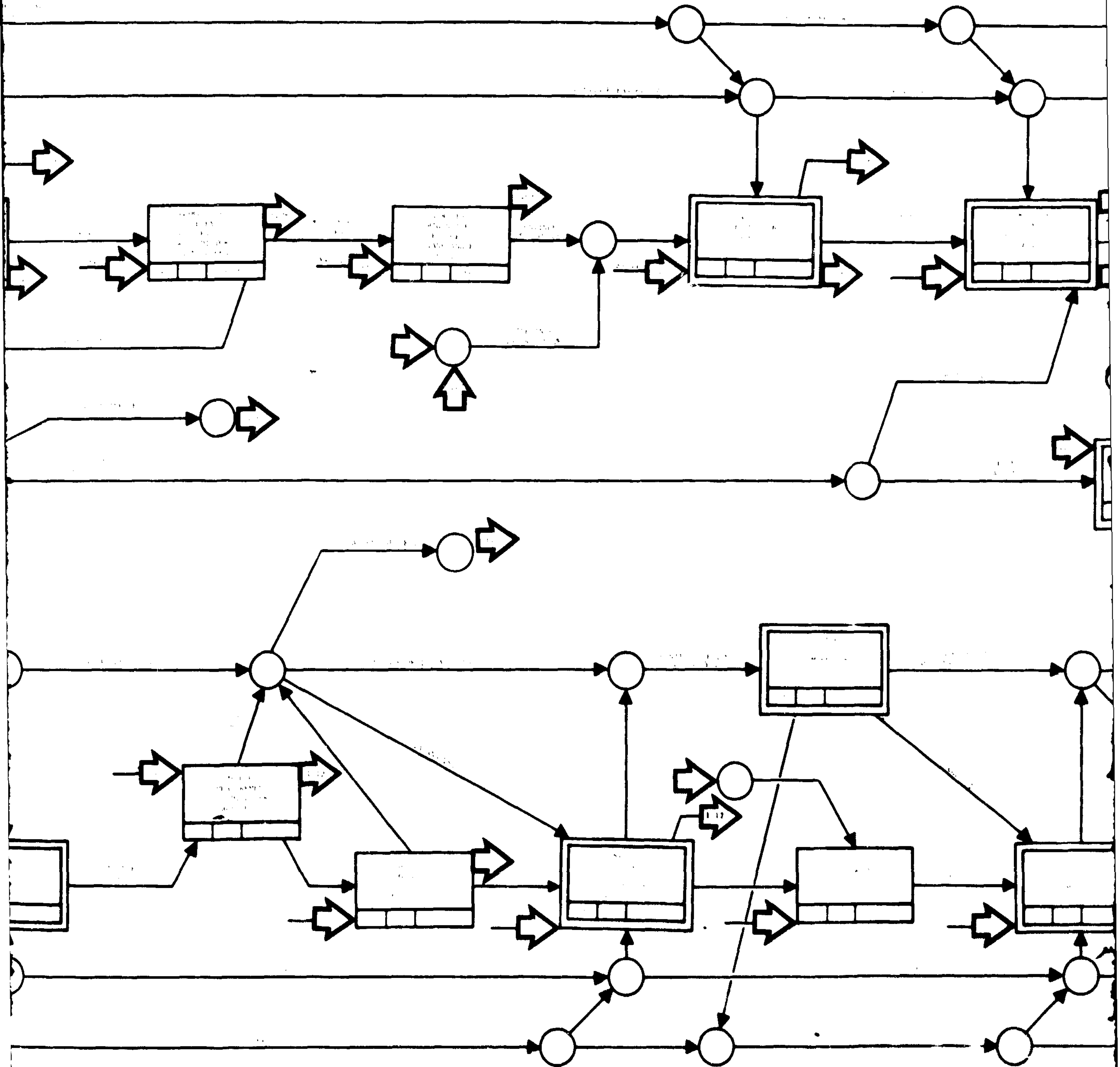
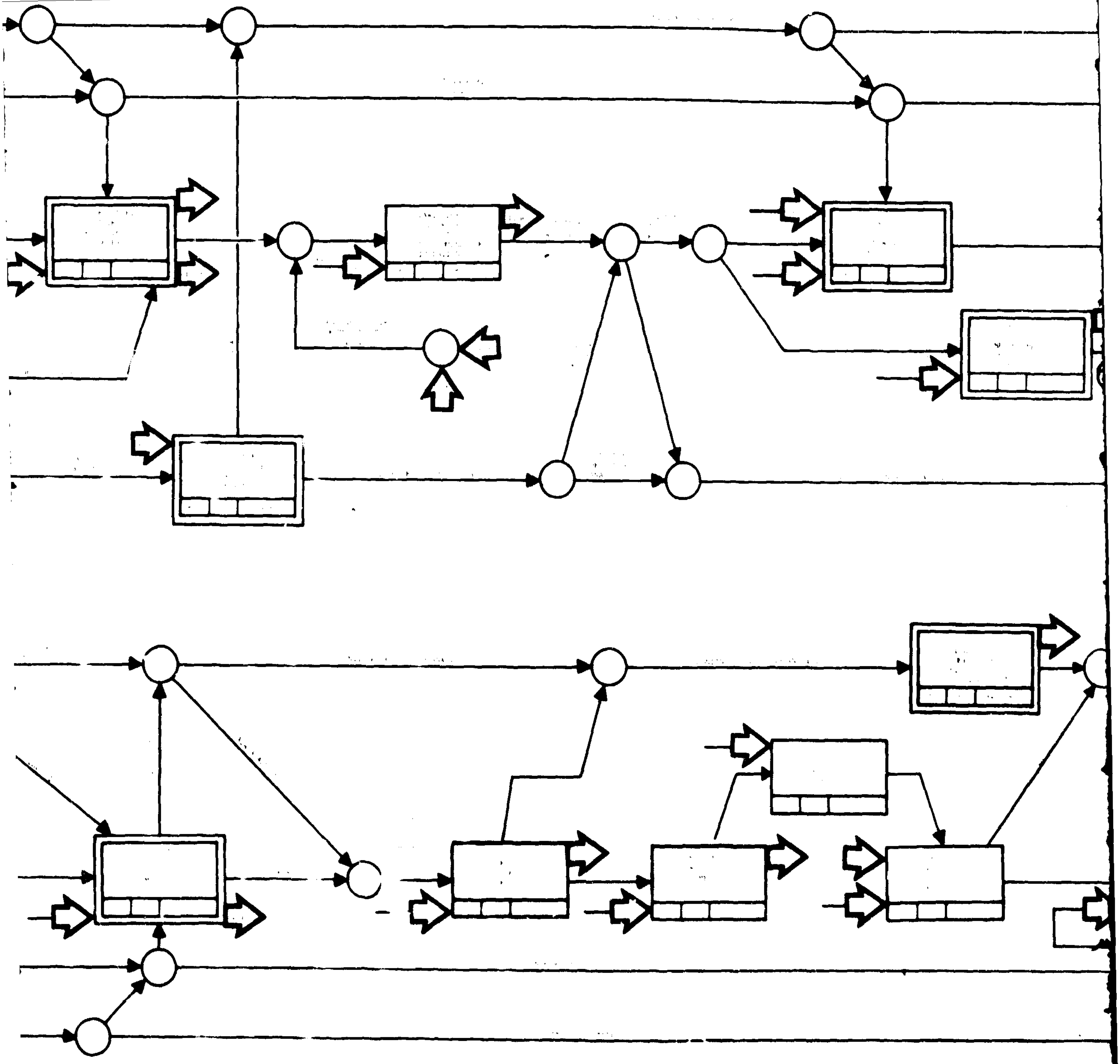
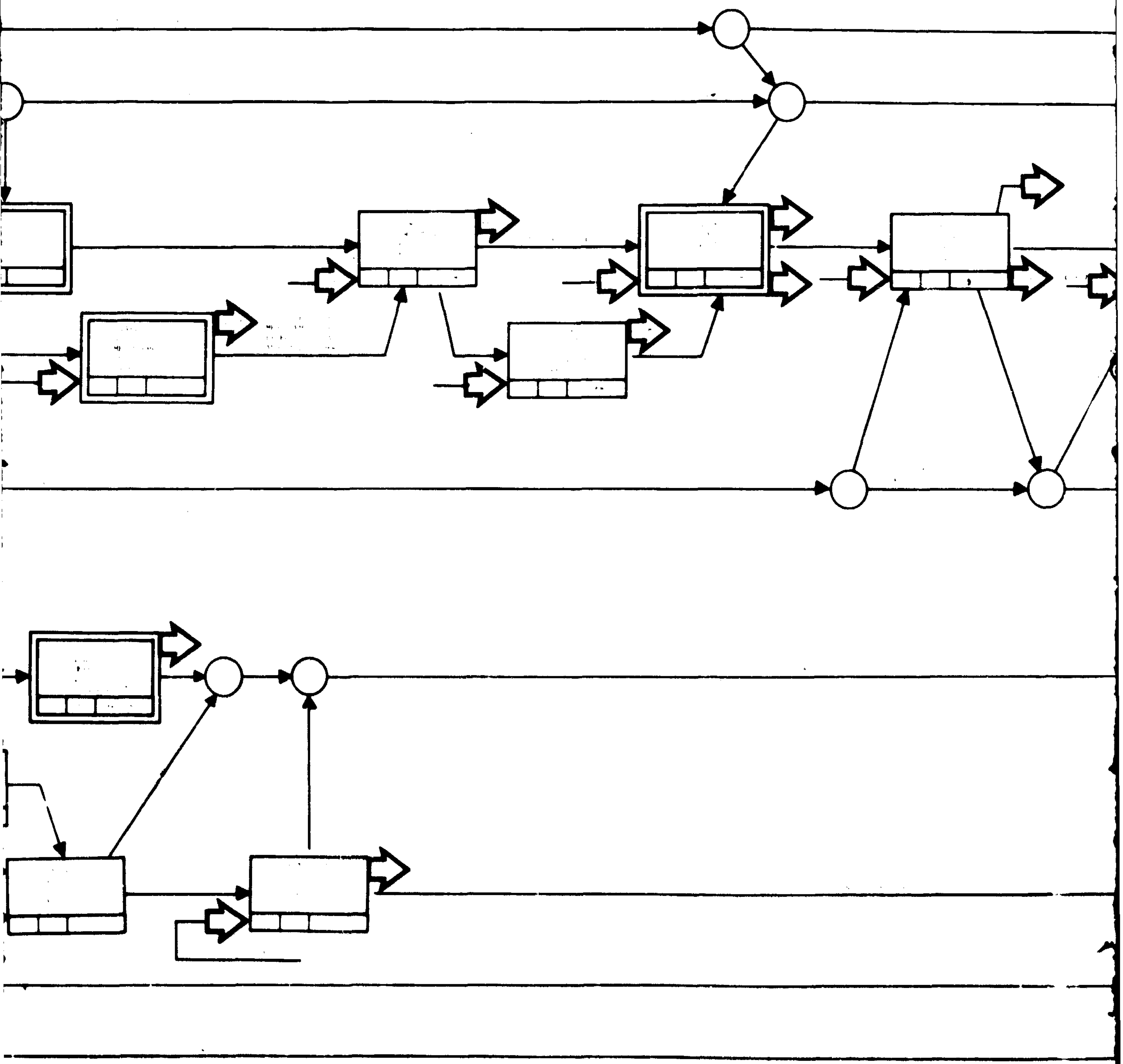

1.11 FAN AND COMPRESSOR







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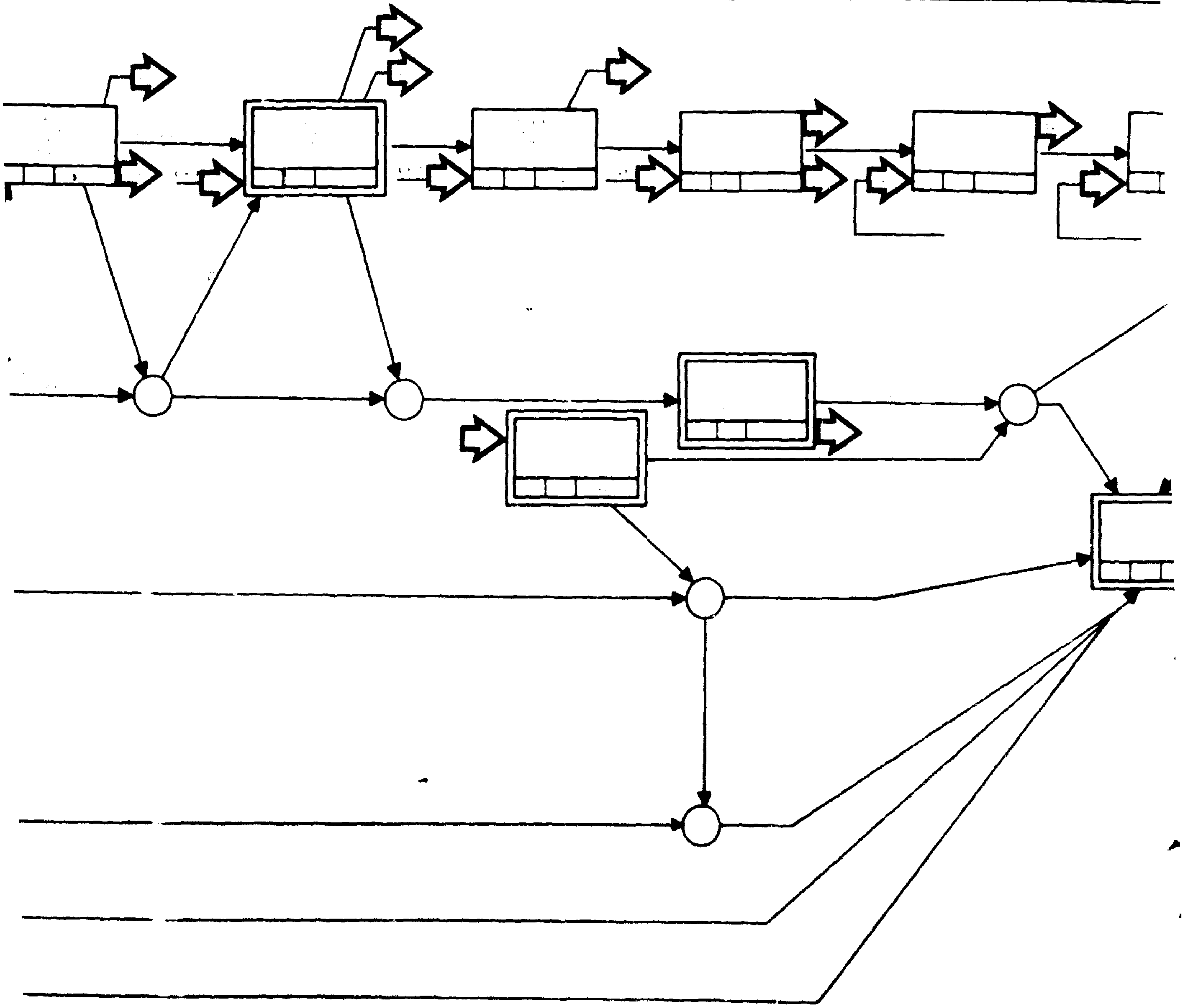
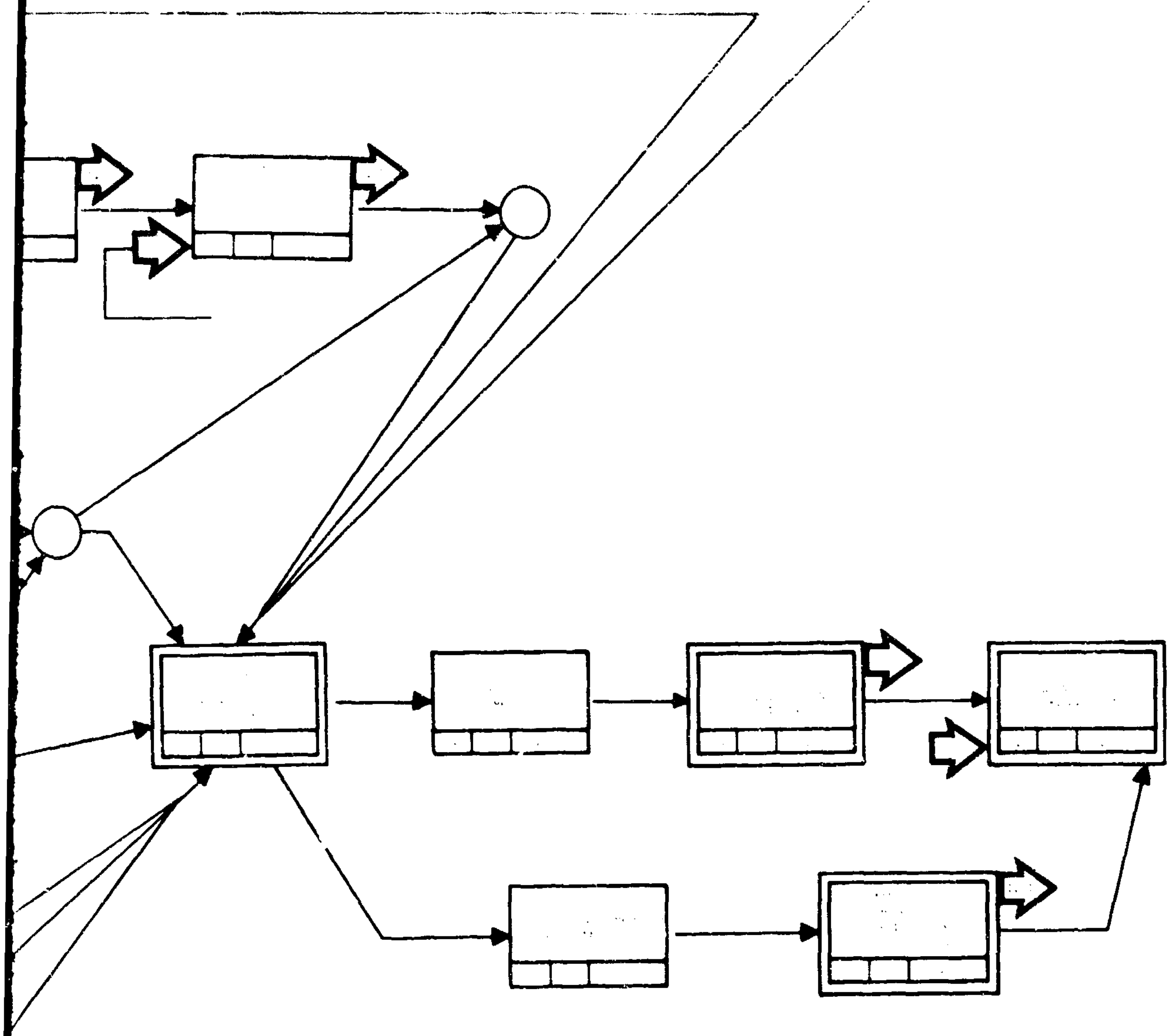


Figure 22



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1.12 PRIMARY COMBUSTOR

Development of the primary combustor is assisted by early testing of full-scale component rigs for rapid evaluation of configuration changes and design developments to supplement the engine test program. This results in a "weeding" process whereby only configurations with the greatest potential are incorporated into the engine system for continued testing.

An additional full-scale 120-degree segment rig will be fabricated during Phase III and a 30-degree segment rig will be transferred from a related program to supplement the rigs available from Phase II-C.

The component test rigs for this program include a full-scale annular combustor, a 30-degree segment combustor, two full-scale 120-degree segment combustors, and a two-dimensional water table. In addition, primary combustor data will also be obtained from the combined turbine primary combustor development program in the full-scale high spool turbine rig. Supplementary testing for fuel nozzle development and manifold flow distribution will also be accomplished to support the combustor program. The fuel nozzles will be tested on a flow calibration bench prior to their use in the combustor. Manifold flow distribution tests will be conducted on a flow calibration bench to evaluate configurations for engine test.

The full-scale annular primary combustor rig consists of a JT4 engine with the primary combustor section adapted to incorporate the diffuser and the inner and outer primary wall contours of the JTF17 engine. The rig will be used to evaluate configurations which have already indicated high performance potential in the 30-degree and 120-degree segment rigs. The full-scale annular rig sea level test program will be directed toward the following:

1. Development of satisfactory discharge temperature patterns
2. Development to achieve the required combustion efficiency through the engine range of temperature rise conditions
3. Development of satisfactory ignition characteristics
4. Durability development at pressure levels equal to SLTO
5. Evaluation of discharge temperature profile s[illegible]ity and durability to design modifications.

The annular primary combustor testing for the FTS and certification engine configurations will be accomplished on JTF17 engine test programs with support from the segment rigs for rapid evaluation of configuration changes. Sea level durability, altitude performance, and altitude ignition characteristics will be a part of the primary combustor development program on the prototype engine.

The 30-degree segment and both of the 120-desgree segment rigs will be subjected to tests to evaluate the following:

1. Combustor discharge temperature profile in the intermediate pressure range of engine operation

2. Combustor front end fuel/air ratio effects

3. Environmental temperature effects on fuel nozzle performance

4. Development of the ignition source location and evaluation of ignition schemes witn respect to relight capability

5. Combustor liner wall temperature measurement to assist in development of combustor durability

6. Ignition and durability characteristics over the altitude operating range.

Fuel nozzle bench testing for the primary combustor will encompass the evaluation of spray pattern, spray angle, and flow calibrations involving the determination of hysteresis characteristics and repeatability.

The major milestones, network chart and event dictionary for the primary combustor are shown in figures 23 and 24, respectively.

A detailed description of the primary combustor development is presented in the Test and Certification Plan, Volume III, Report E, and test planning and integration is presented in Test, Volume IV, Report E.

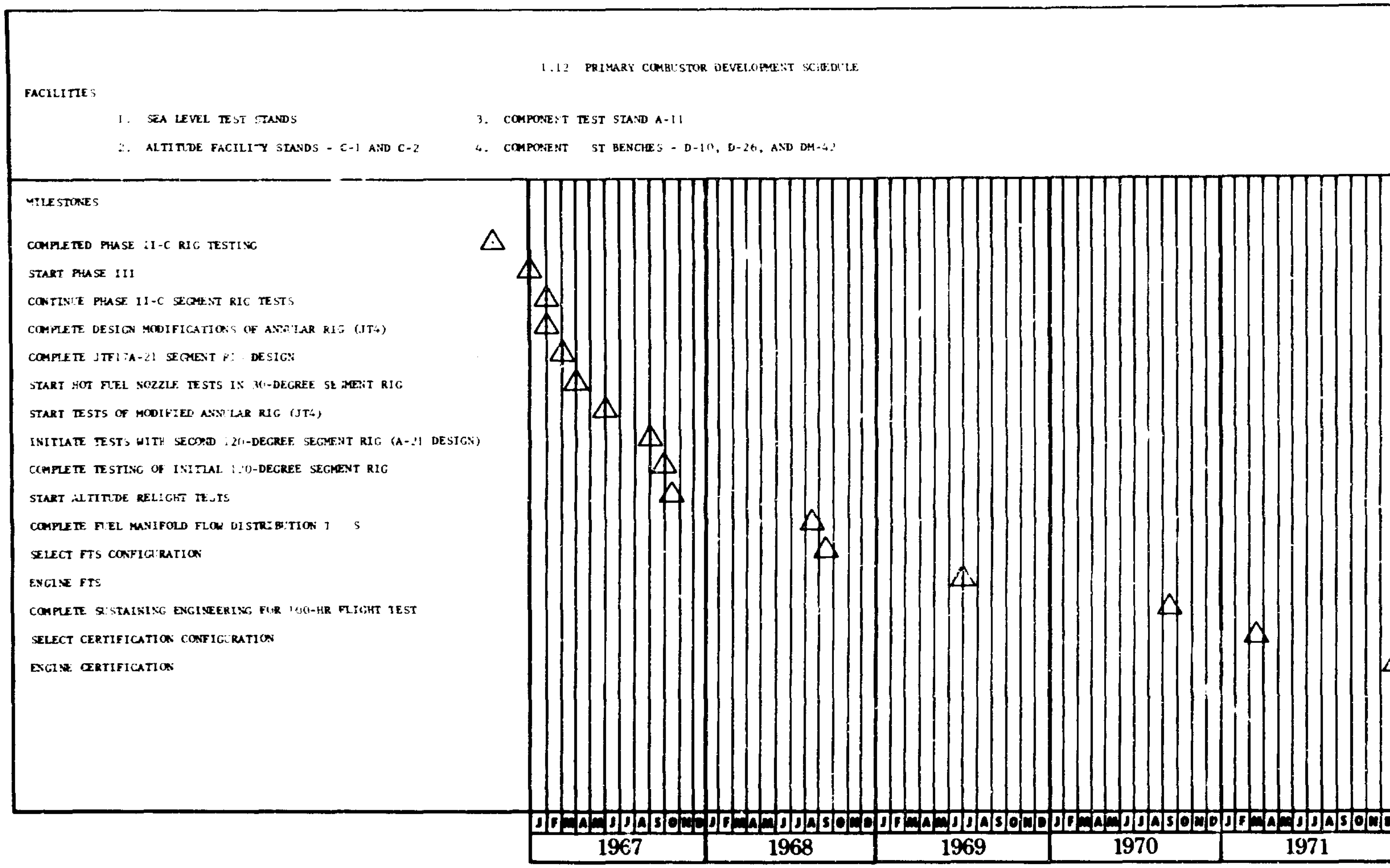

Figure 23. 1.12 Primary Combustor

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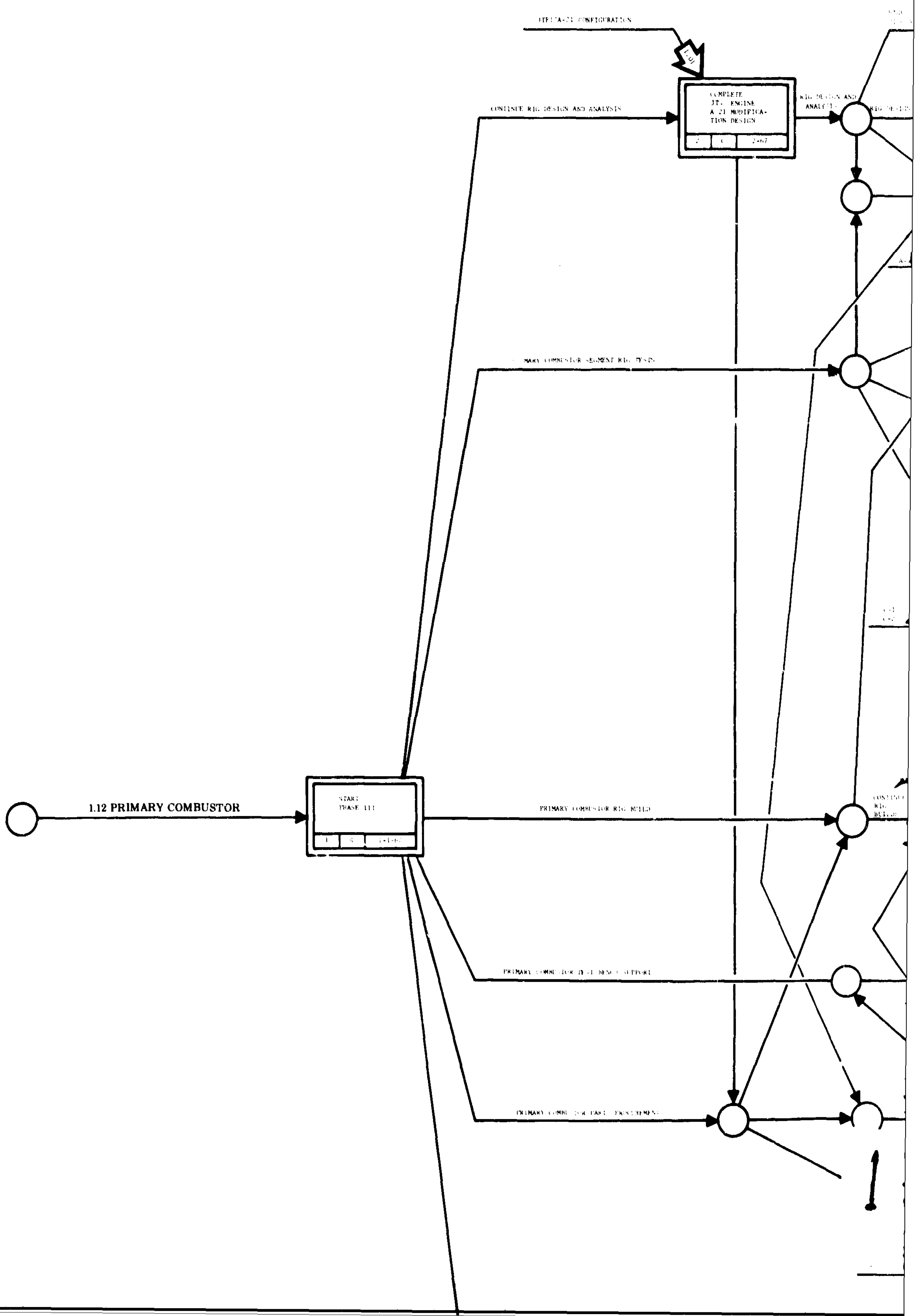
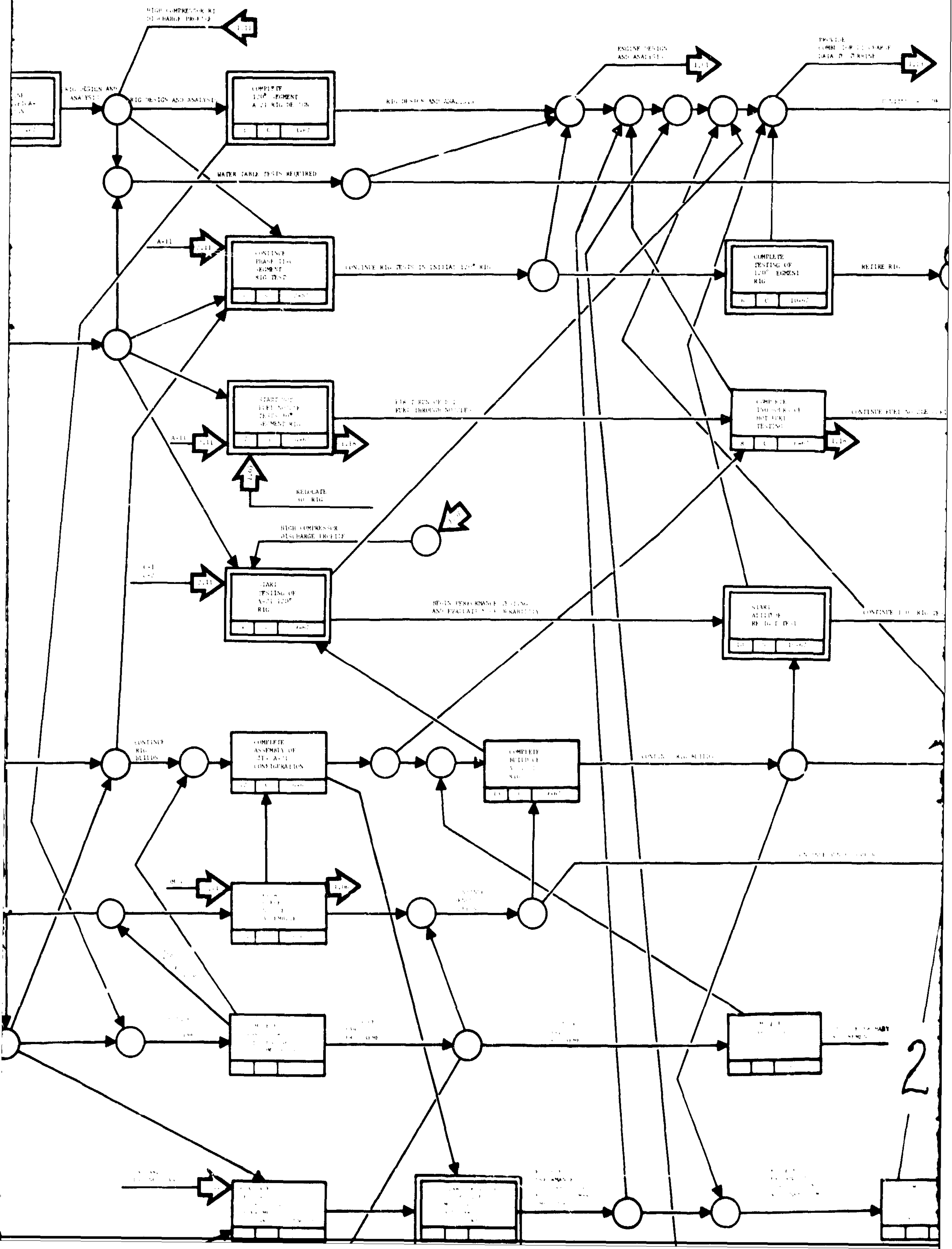
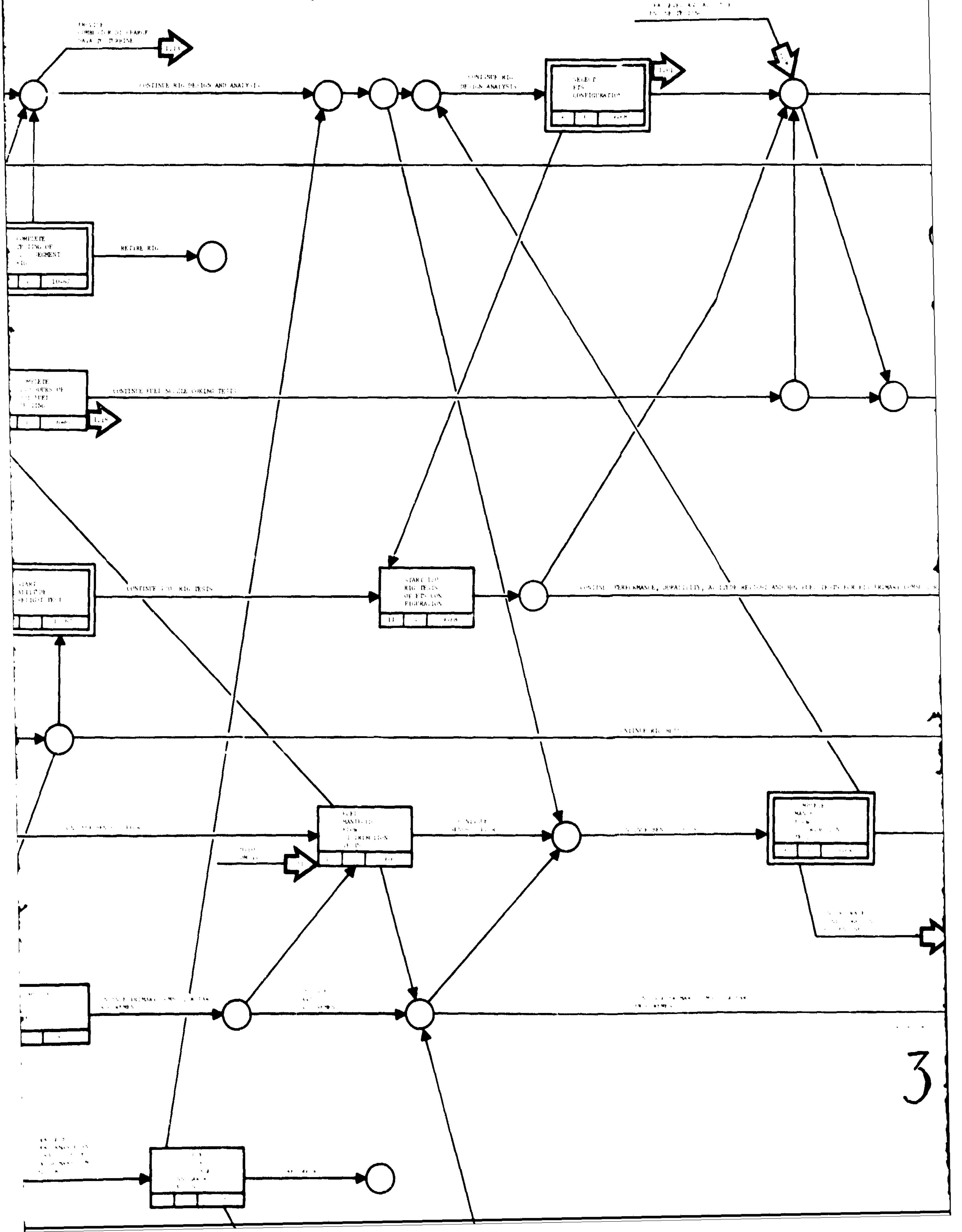


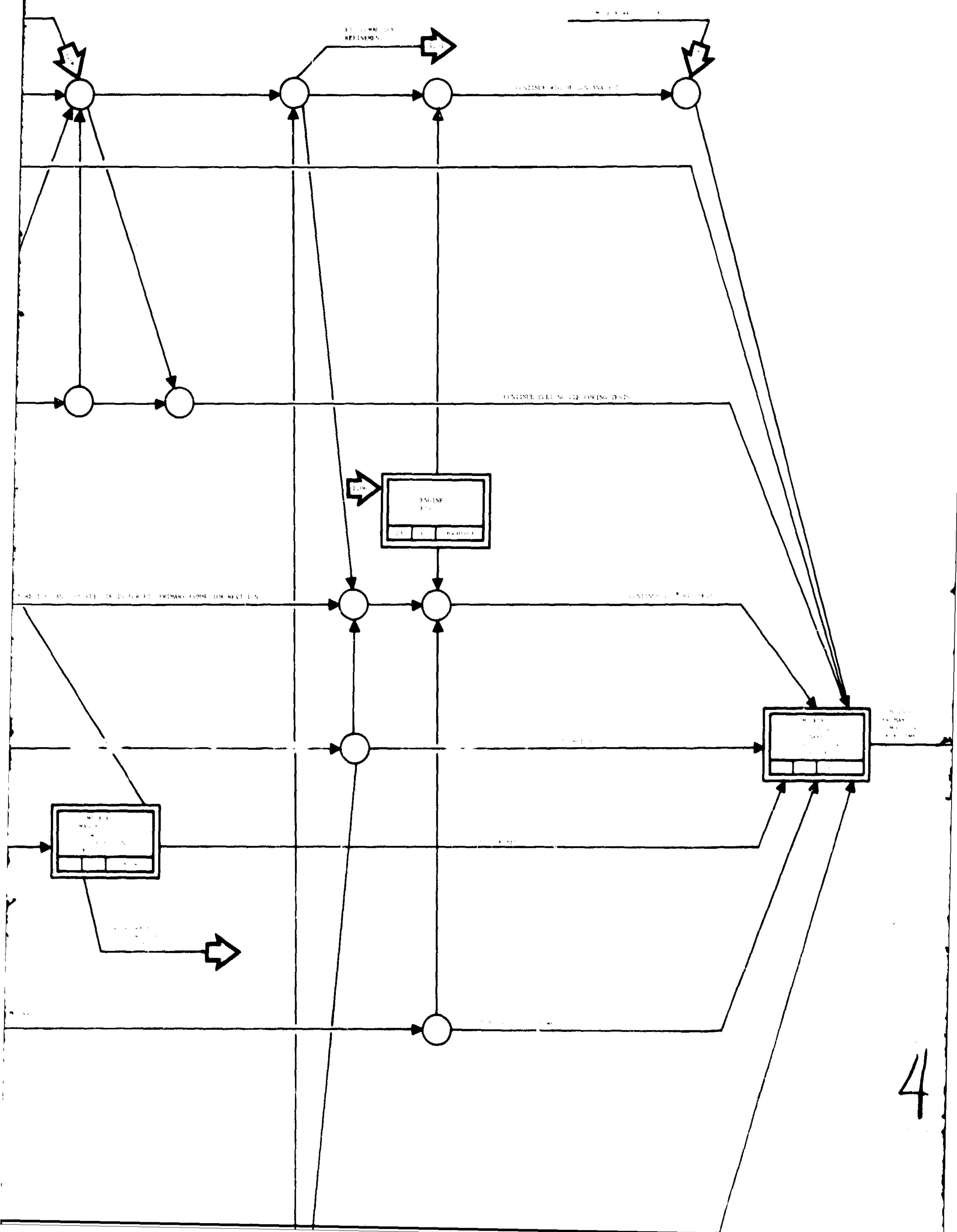
COMPLETE
JT- ENGINE
A 21 MODIFICA-
TION DESIGN
1.01
2-67
CONTINUE RIG DESIGN AND ANALYSIS
1.12 PRIMARY COMBUSTOR
START
PHASE III
PRIMARY COMBUSTOR RIG BUILD

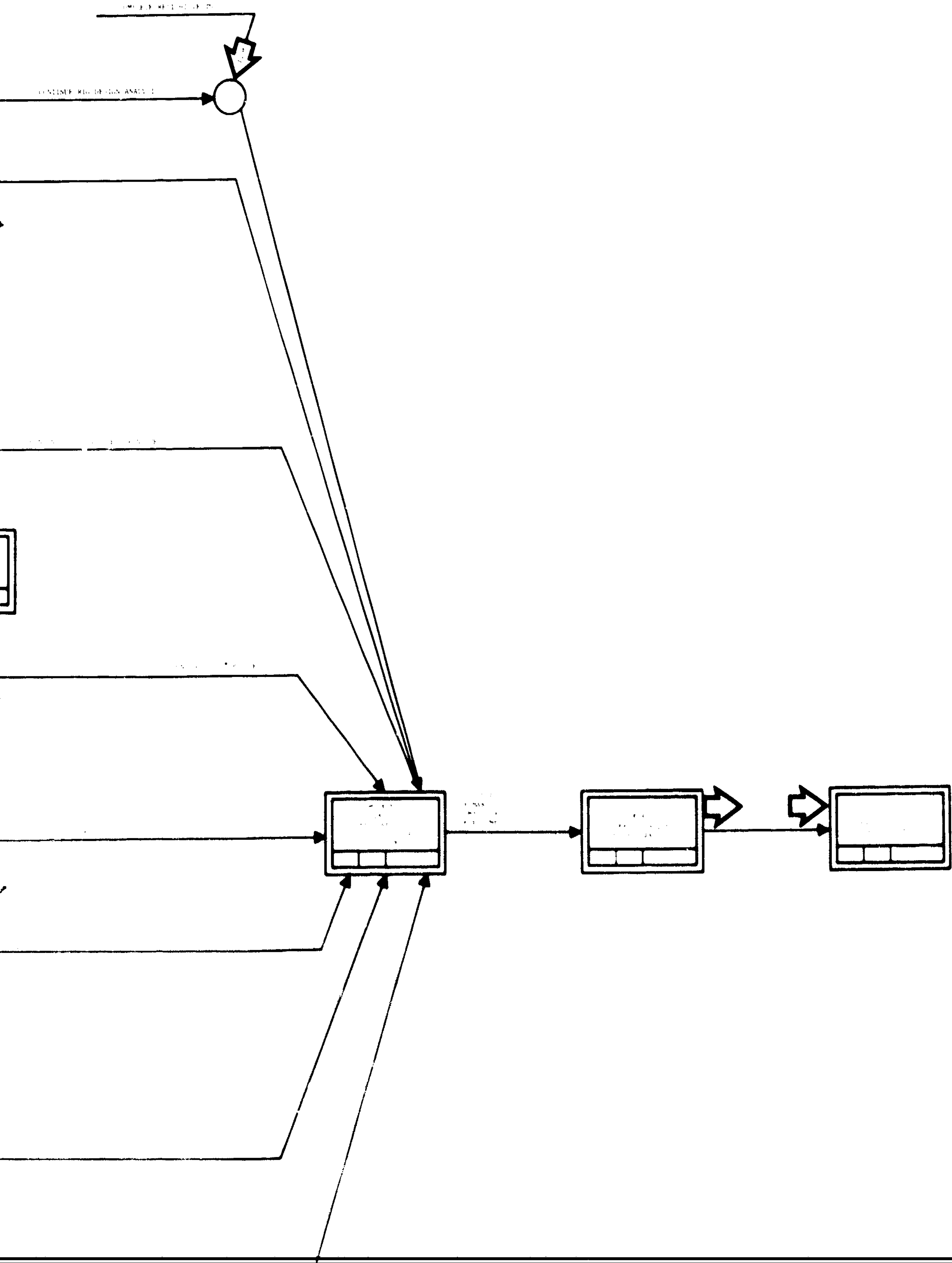


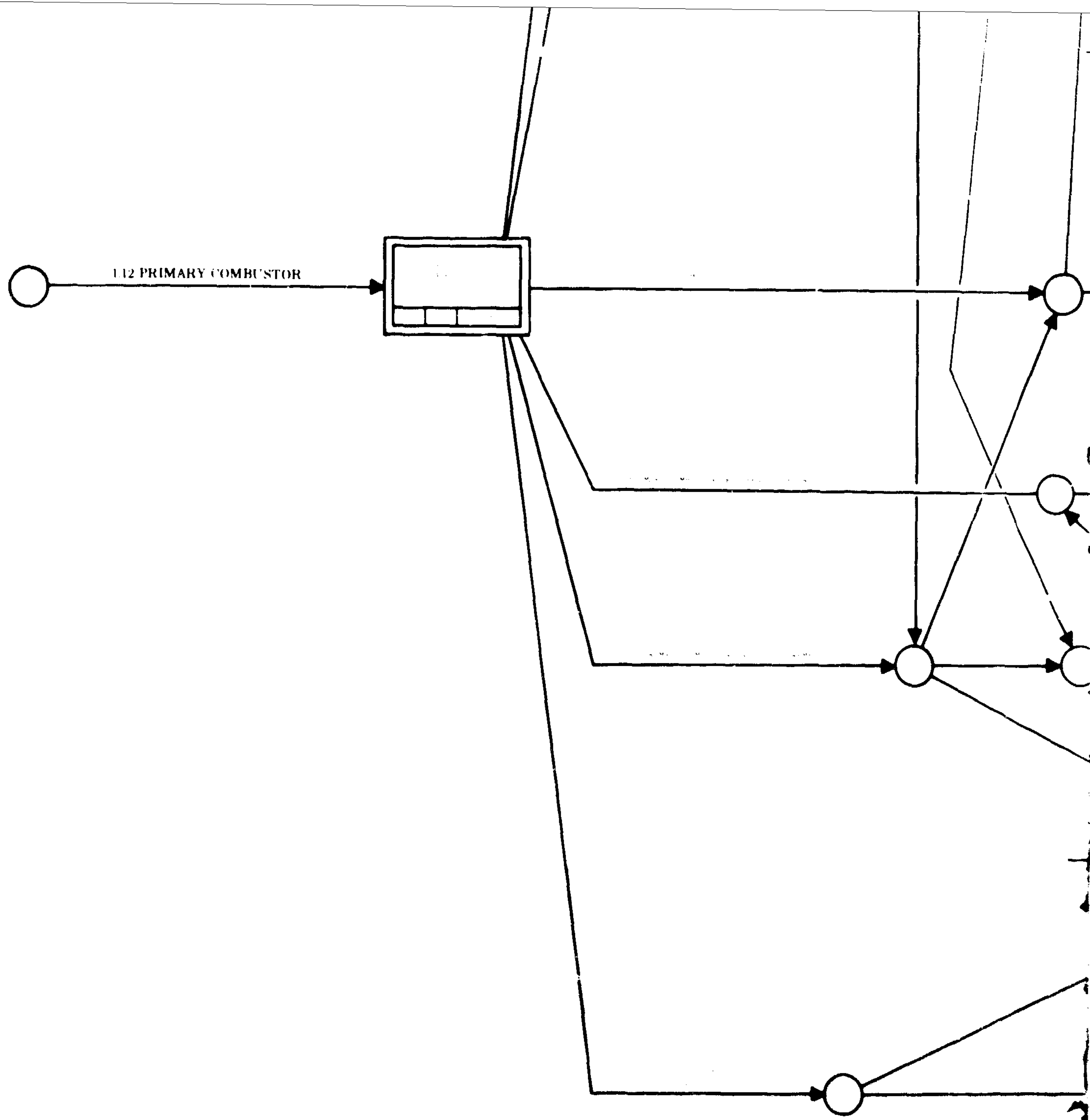
RIG DESIGN AND ANALYSIS
COMPLETE 120° SEGMENT
WATER TABLE TESTS REQUIRED
ENGINE DESIGN AND ANALYSIS
CONTINUE PHASE II-A SEGMENT RIG TEST
CONTINUE RIG TESTS IN INITIAL 120° RIG
COMPLETE TESTING OF 120° SEGMENT RIG
RETIRE RIG
A-11
RELOCATE
HIGH COMPRESSOR DISCHARGE PROFILE
START TESTING OF
BEGIN PERFORMANCE TESTING
CONTINUE FUEL NOZZLE
COMPLETE ASSEMBLY OF
CONFIGURATION
CONTINUE RIG BUILDS
COMPLETE
2

1.12 Primary Combustor




REFINEMENT
ENGINE
PRIMARY COMBR FOR NEXT
4





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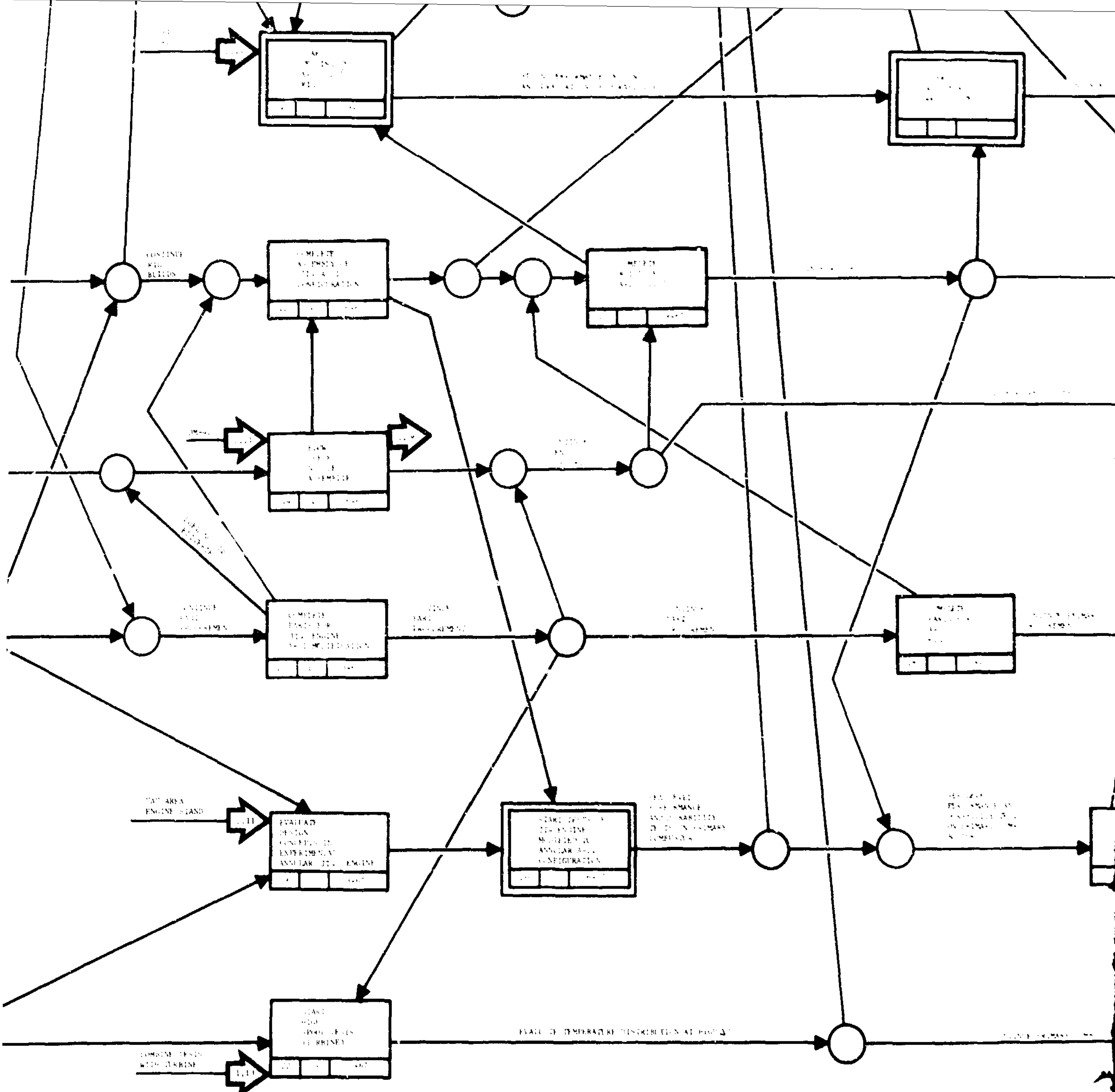
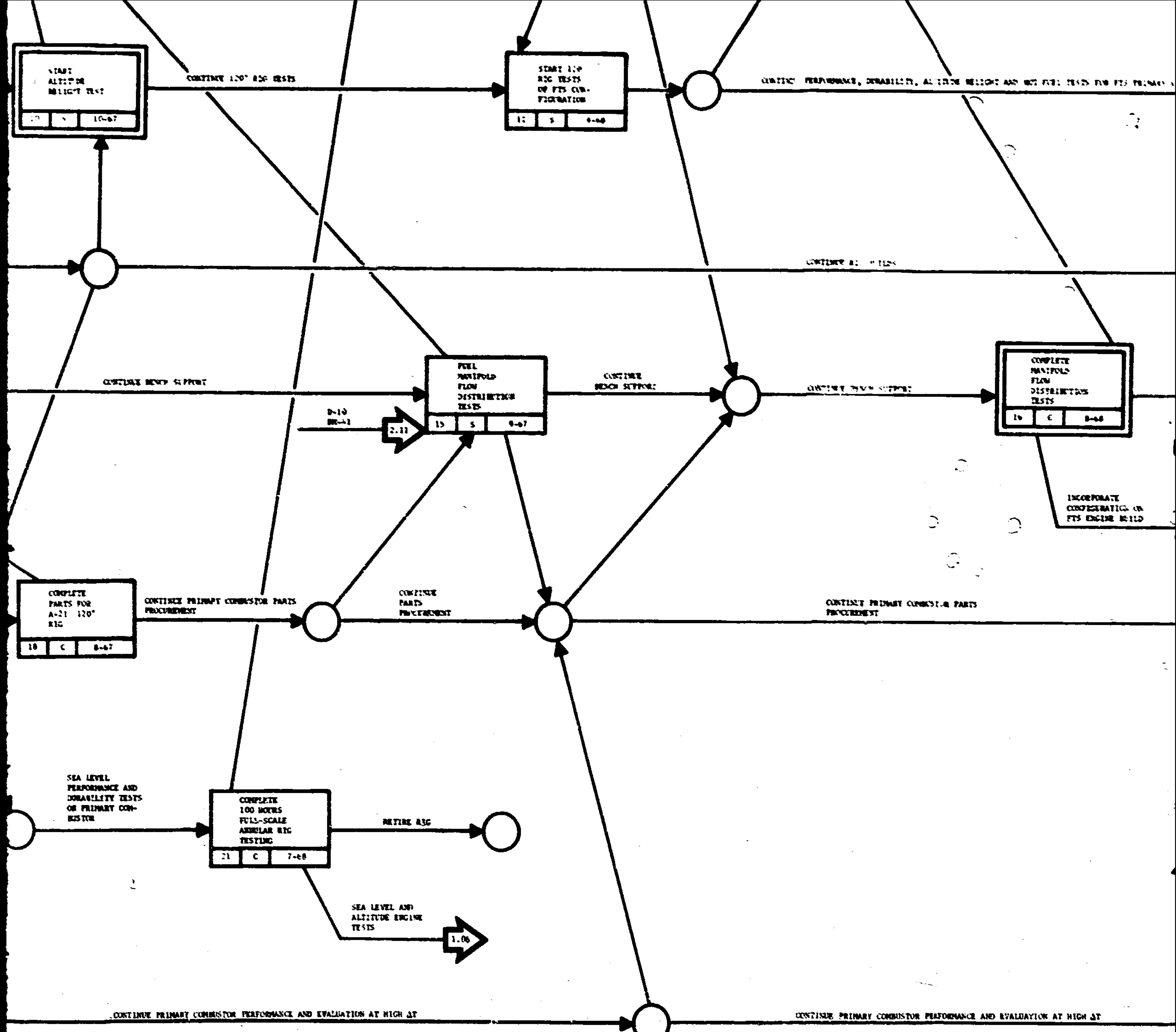
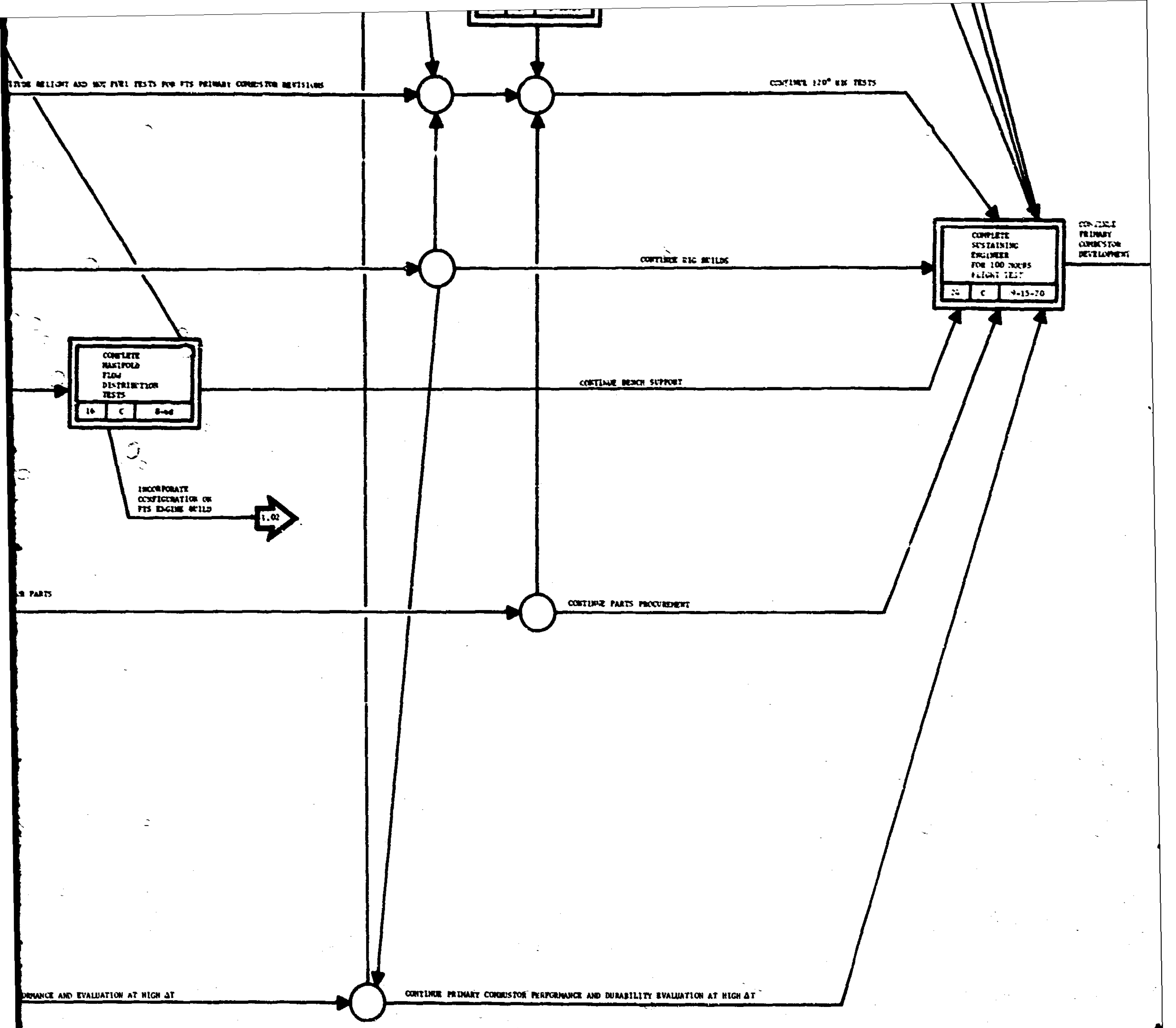

CONTINUE RIG BUILDS
EVALUATE DESIGN CONCEPTS IN EXPERIMENTAL ANNULAR ENGINE
ENGINE STAND
COMBINE TESTS WITH TURBINE
CONFIGURATION
EVALUATE TEMPERATURE DISTRIBUTION AT
Description and Criteria

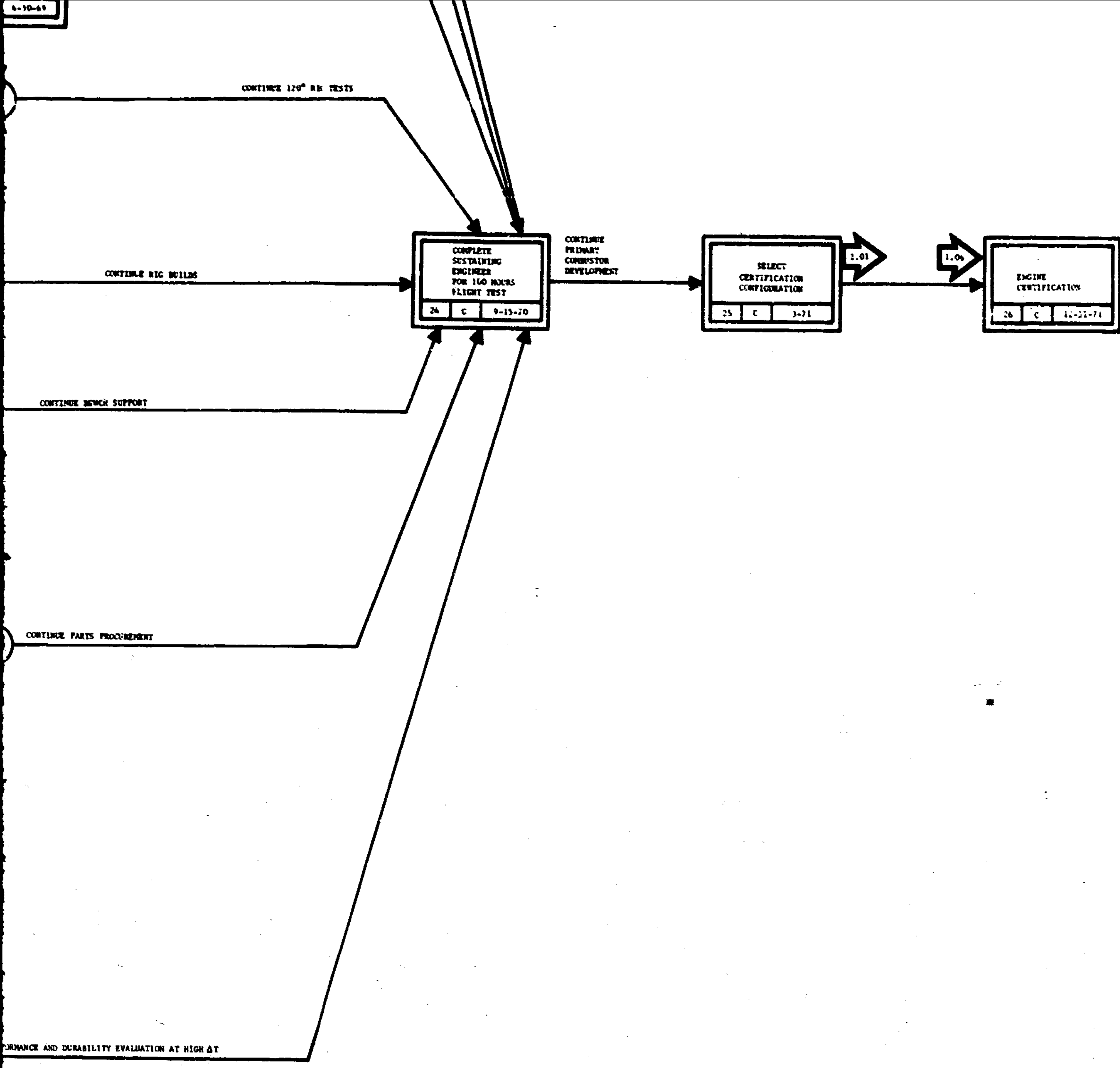


EVENT DICTIONARY
1.12 PRIMARY COMBUSTOR

Event Number	Description and Criteria
10	**START ALTITUDE RELIGHT TEST** Begin testing the relight characteristics of the JTF17 combustor at simulated altitude conditions in the 120-degree segment rig.
11	**START 120-DEGREE RIG TESTS OF FTS CONFIGURATION** Start testing the FTS combustor in the 120-degree segment rig to determine minor refinements for the FTS engine. The combustor being tested will have incorporated all long-leadtime features for the FTS configuration.
12	**COMPLETE ASSEMBLY OF JT4 A-21 CONFIGURATION** Complete the modification of the JT4 engine combustion section to the JTF17 configuration. Completion of the JT4 engine build with the JTF17 combustor installed.
13	**COMPLETE BUILD OF A-21 120-DEGREE RIG** Complete the assembly of the new 120-degree segment rig. The rig will be ready for delivery to test.
14	**FLOW CHECK NOZZLE ASSEMBLIES** Provide test bench support to flow check fuel nozzle assemblies for both rigs and engines. The first set of JTF17 fuel nozzle assemblies will be completed for the modified JT4 engine.
15	**FUEL MANIFOLD FLOW DISTRIBUTION TESTS** Begin flow bench testing to determine the configuration and orifice requirements to uniformly distribute fuel to the combustor nozzle and support assemblies.
16	**COMPLETE MANIFOLD FLOW DISTRIBUTION TESTS** Conduct fuel manifold flow distribution test to determine the configuration and orifice requirements to uniformly distribute fuel to the combustor nozzle and support assemblies. Incorporate the configuration in the build of the FTS engine.
17	**COMPLETE PARTS FOR JT4 ENGINE A-21 MODIFICATION** All parts delivered for the rebuild of the JT4 engine with the JTF17 primary combustor.
18	**COMPLETE PARTS FOR A-21 120-DEGREE RI[illegible]** All parts delivered to the build of [illegible] 120-degree segment combustor rig with [illegible] JTF17 primary combustor configuration
19	**EVALUATE DESIGN CONCEPTS IN EXPERIMEN[illegible] ANNULAR JT4 ENGINE** Begin testing of basic design concept[illegible] JTF17 combustor in the experimental [illegible] of the annular JT4 engine.
20	**START TESTS OF JT4 ENGINE MODIFIED TO ANNULAR A-21 CONFIGURATION** Begin running the combustor tests [illegible]
21	**COMPLETE 100 HOUR FULL-SCALE ANNULAR [illegible] TESTING** Complete a total of 100 hours of JT4 [illegible] operation while testing primary combu[illegible] configuration.



Description and Criteria	Event Number	Description and Criteria
COMPLETE PARTS FOR A-21 120-DEGREE RIG All parts delivered to the build of the new 120-degree segment combustor rig with the JTF17 primary combustor configuration.	22	**START HIGH SPOOL TESTS** Begin a combined test program with the turbine development by running high combustor temperature rise conditions. Interface with the turbine network 1.13. Installation of the rig on the test stand and the first test started.
EVALUATE DESIGN CONCEPTS IN EXPERIMENTAL ANNULAR JT4 ENGINE Begin testing of basic design concepts for the JTF17 combustor in the experimental configuration of the annular JT4 engine.	23	**ENGINE FTS** Reference engine network 1.06 for description and criteria.
START TESTS OF JT4 ENGINE MODIFIED TO ANNULAR A-21 CONFIGURATION Begin running the combustor tests on the modified JT4 engine	4	**COMPLETE SUSTAINING ENGINEERING FOR 100 HOUR FLIGHT TEST** End of Phase III. Completion of 100 hours of flight testing.
COMPLETE 100 HOUR FULL-SCALE ANNULAR RIG TESTING Complete a total of 100 hours of JT4 engine operation while testing primary combustor configuration.	25	**SELECT CERTIFICATION CONFIGURATION** Provide design with information for the primary combustor to be incorporated in the certification engine design. Interface with design network 1.01 and fabrication network 1.02. The combustor configuration selected will have incorporated all long-lead-time features for the certification engine.
	26	**ENGINE CERTIFICATION** Reference engine network 1.06 for description and criteria.



ription and Criteria

TESTS
test program with the turbine
nning high combustor tem-
nditions. Interface with the
1.13. Installation of the rig
d and the first test started.

network 1.06 for description

ING ENGINEERING FOR 100 HOUR

Completion of 100 hours of

TION CONFIGURATION
ith information for the primary
incorporated in the certification
interface with design network
tion network 1.02. The combustor
lected will have incorporated
me features for the certification

ATION
network 1.06 for description

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1.13 TURBINE

The JTF17 turbine design is predicated upon continuous operation at high turbine inlet temperatures at cruise, and is an outgrowth of the aircooled turbine developed for the high Mach number J58 engine. The necessity for turbine cooling in the Supersonic Transport engine requires extensive testing of airfoil cooling schemes and their effects on turbine performance. In addition, the requirements for durability, equivalent to current commercial aircraft engines operating at lower turbine inlet temperatures, indicate that extensive testing be done to evaluate thermal fatigue and endurance capabilities of the airfoils.

Resistance to thermal fatigue is an important consideration in the design and development of the JTF17 turbine. Extensive testing was conducted during Phase II-C to evaluate convective cooled and film cooled airfoil schemes for their resistance to thermal fatigue. Cyclic endurance programs conducted in the JT4 turbine development engine (High Spool Rig) indicated that airfoils with interruptions in the stressed walls near the leading edge, such as holes and slots, had virtually no resistance to thermal fatigue. Convectively cooled airfoils tested in the cyclic endurance indicated that mass distribution of the metal across the chord and internal cooling geometry in the airfoil were sensitive parameters in achieving the required thermal fatigue capability.

In continuation of the work done in Phase II-C, the refined airfoil designs in the JTF17 will be evaluated for their resistance to thermal fatigue in the JTF17 high spool rig. Testing will be accomplished by subjecting the parts to alternate periods at maximum turbine inlet temperature and minimum turbine inlet temperature to expose the parts to the most severe thermal fatigue environment anticipated. The 1st-stage turbine disk will also be evaluated for thermal gradients in the above mentioned testing program. Another objective which will be accomplished on the full-size high-spool rig is the verification of predicted metal temperatures of the various parts at engine operating conditions. Still another objective of these rig tests will be the verification of design criteria by measuring the vibratory and stress parameters on blades, vanes, disks, and hubs.

The aerodynamic performance of airfoils utilizing cooling airflow in the quantities required for cruise operation can adversely affect overall turbine efficiency. Cooling airflow injection into the mainstream flow has been studied in Phase II-C testing and optimized injection geometry has been established for the JTF17 airfoils. Continued studies of airfoil cooling air injection geometry, effects of platform leakage, and trailing edge discharge characteristics will be conducted in aerodynamic cascade rigs.

Cooling air injection evaluations will be run to optimize the method of admitting and exhausting blade and vane cooling air. This will include an evaluation of the effectiveness of leading edge, pressure side, suction side, trailing edge, and spanwise length discharge configurations. Laminar flow characteristics will also be determined with respect to thermodynamic advantages, surface condition, air exit location and configuration required

to maintain laminar flow. The convective cooling program will include evaluations of multichamber, multipass airfoils, and fabricated airfoils such as wafers and thermal skin.

Cascade programs will also be conducted on vanes and blades to investigate heat transfer, and cyclic fatigue life. These programs will be used as screening tests to aid in the selection of configurations for testing in the full-scale rigs.

Testing will be accomplished on the thermodynamic cascade rigs through Phase III to investigate the thermodynamic characteristics of high efficiency convective cooling schemes. These rigs simulate the necessary entrance and exit conditions to test single blades or vanes under engine environmental conditions.

In addition, testing will be accumulated during the early part of Phase III on a thermal shock rig. Various airfoil configurations based on information from thermodynamic and aerodynamic cascade rig data will be tested to determine (1) transient thermal stresses introduced by various cooling schemes, and (2) cyclic thermal fatigue life of airfoils under consideration for JTF17 engine use.

The major milestones, network chart and event dictionary for the turbine are shown in figures 25 and 26, respectively.

A detailed description of the turbine development is presented in the Test and Certification Plan, Volume III, Report E, and test planning and integration is presented in Test, Volume IV, Report E.

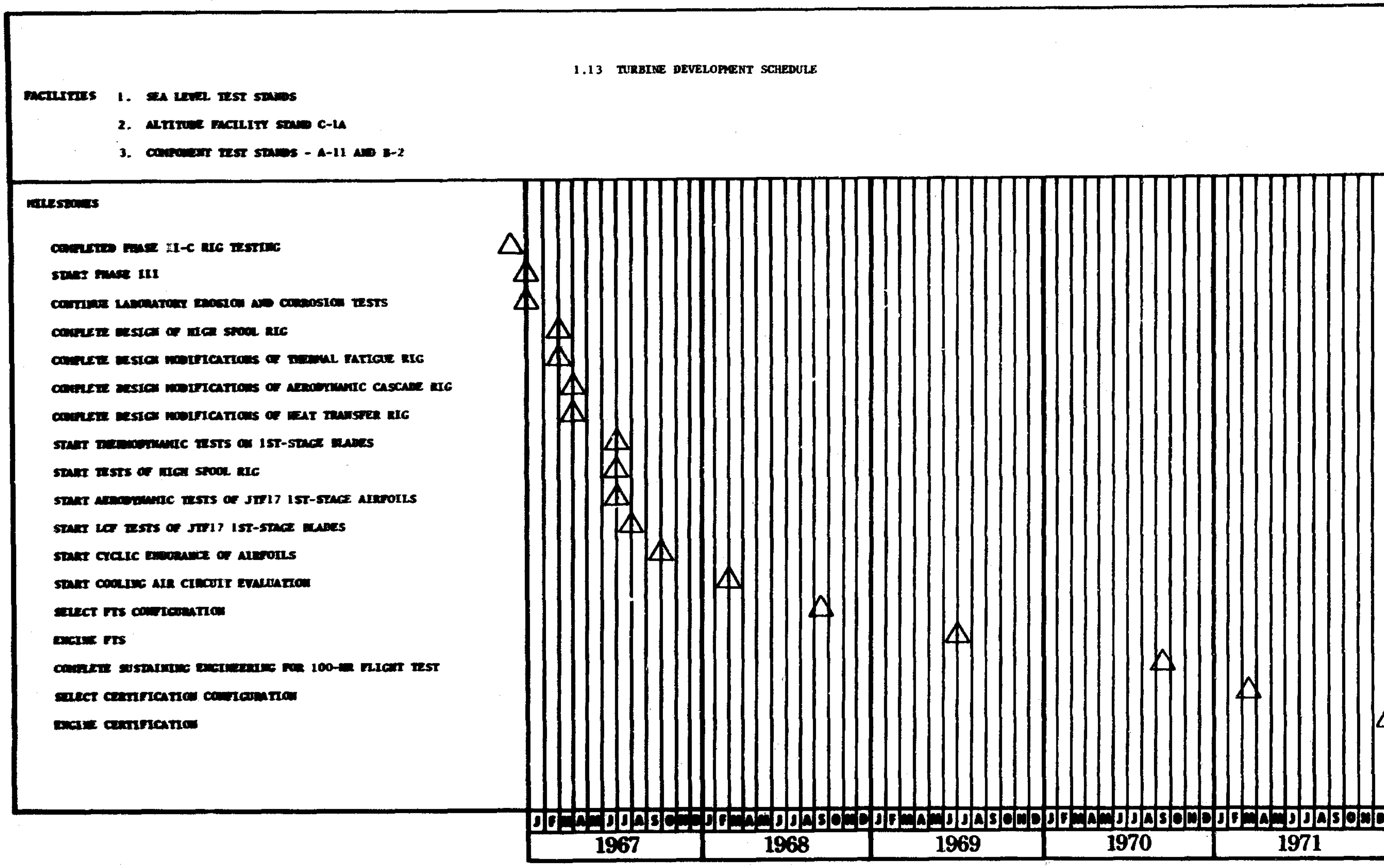

Figure 25. 1.13 Turbine

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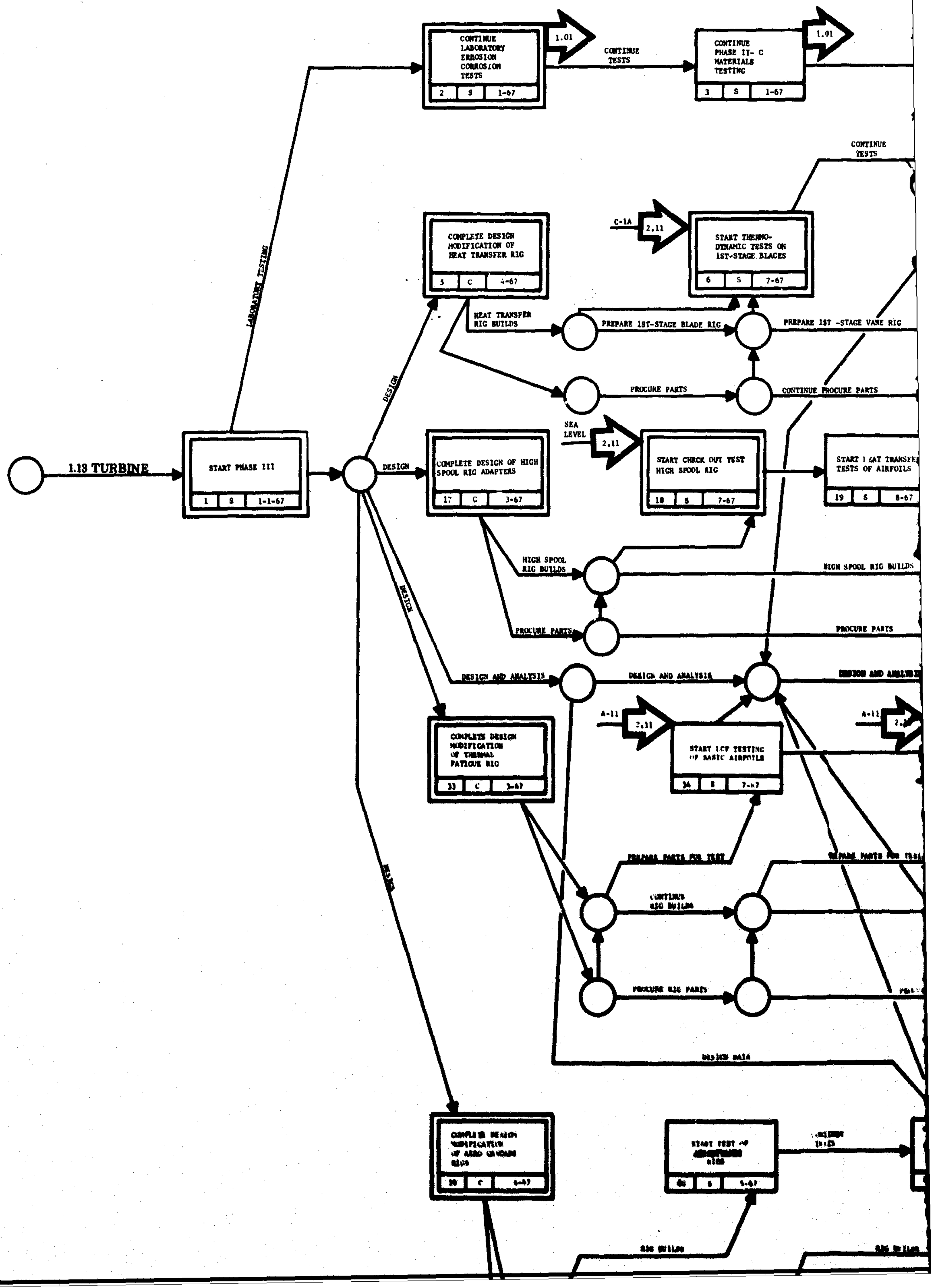
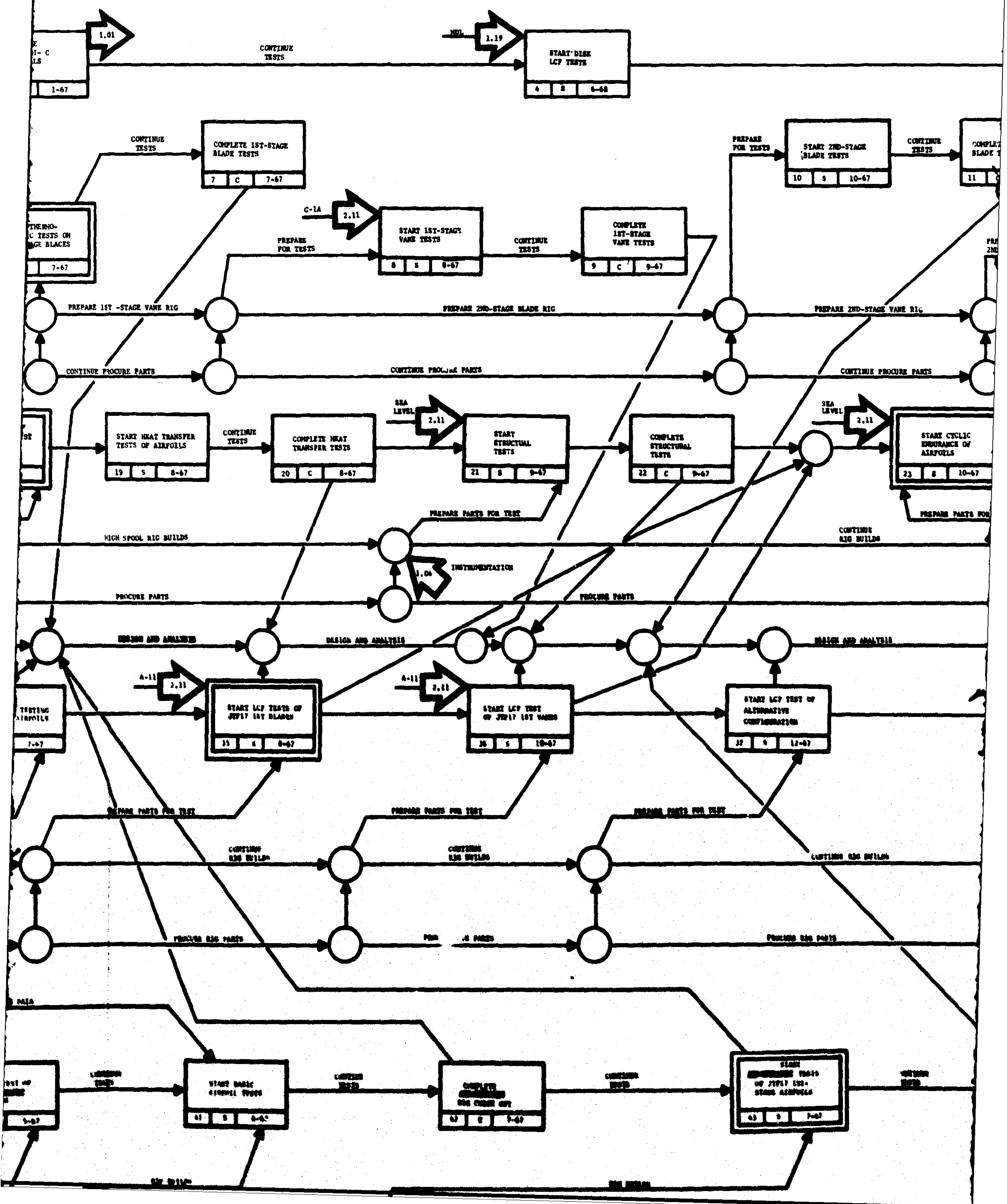


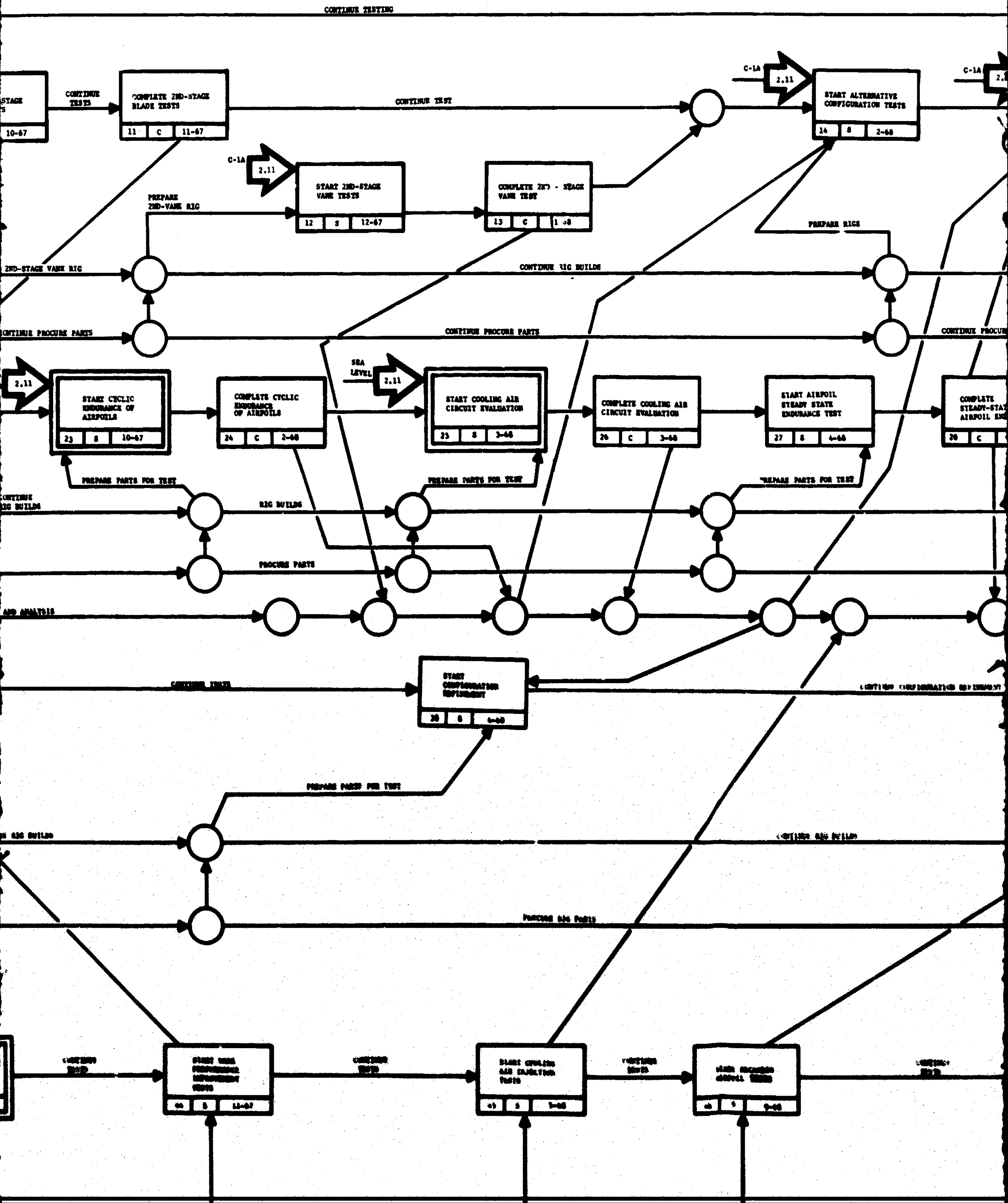
1.13 TURBINE
START PHASE III
1 S 1-1-67
LABORATORY TESTING
CONTINUE LABORATORY ERROSION CORROSION TESTS
2 S 1-67
1.01
CONTINUE TESTS
CONTINUE PHASE II- C MATERIALS TESTING
3 S 1-67
1.01
CONTINUE TESTS
DESIGN
COMPLETE DESIGN MODIFICATION OF HEAT TRANSFER RIG
5 C 4-67
C-1A
2.11
START THERMO-DYNAMIC TESTS ON 1ST-STAGE BLACES
6 S 7-67
HEAT TRANSFER RIG BUILDS
PREPARE 1ST-STAGE BLADE RIG
PREPARE 1ST -STAGE VANE RIG
PROCURE PARTS
CONTINUE PROCURE PARTS
DESIGN
COMPLETE DESIGN OF HIGH SPOOL RIG ADAPTERS
17 C 3-67
SEA LEVEL
2.11
START CHECK OUT TEST HIGH SPOOL RIG
18 S 7-67
START HEAT TRANSFER TESTS OF AIRFOILS
19 S 8-67
HIGH SPOOL RIG BUILDS
HIGH SPOOL RIG BUILDS
PROCURE PARTS
PROCURE PARTS
DESIGN
DESIGN AND ANALYSIS
DESIGN AND ANALYSIS
COMPLETE DESIGN MODIFICATION OF THERMAL FATIGUE RIG
33 C 3-67
A-11
2.11
START LCF TESTING OF BASIC AIRFOILS
34 S 7-67
A-11
PREPARE PARTS FOR TEST
CONTINUE RIG BUILDS
PROCURE RIG PARTS
DESIGN DATA
DESIGN
COMPLETE DESIGN MODIFICATION OF AERO CASCADE RIGS
C
START TEST OF RIGS
S
RIG BUILDS
RIG BUILDS

12

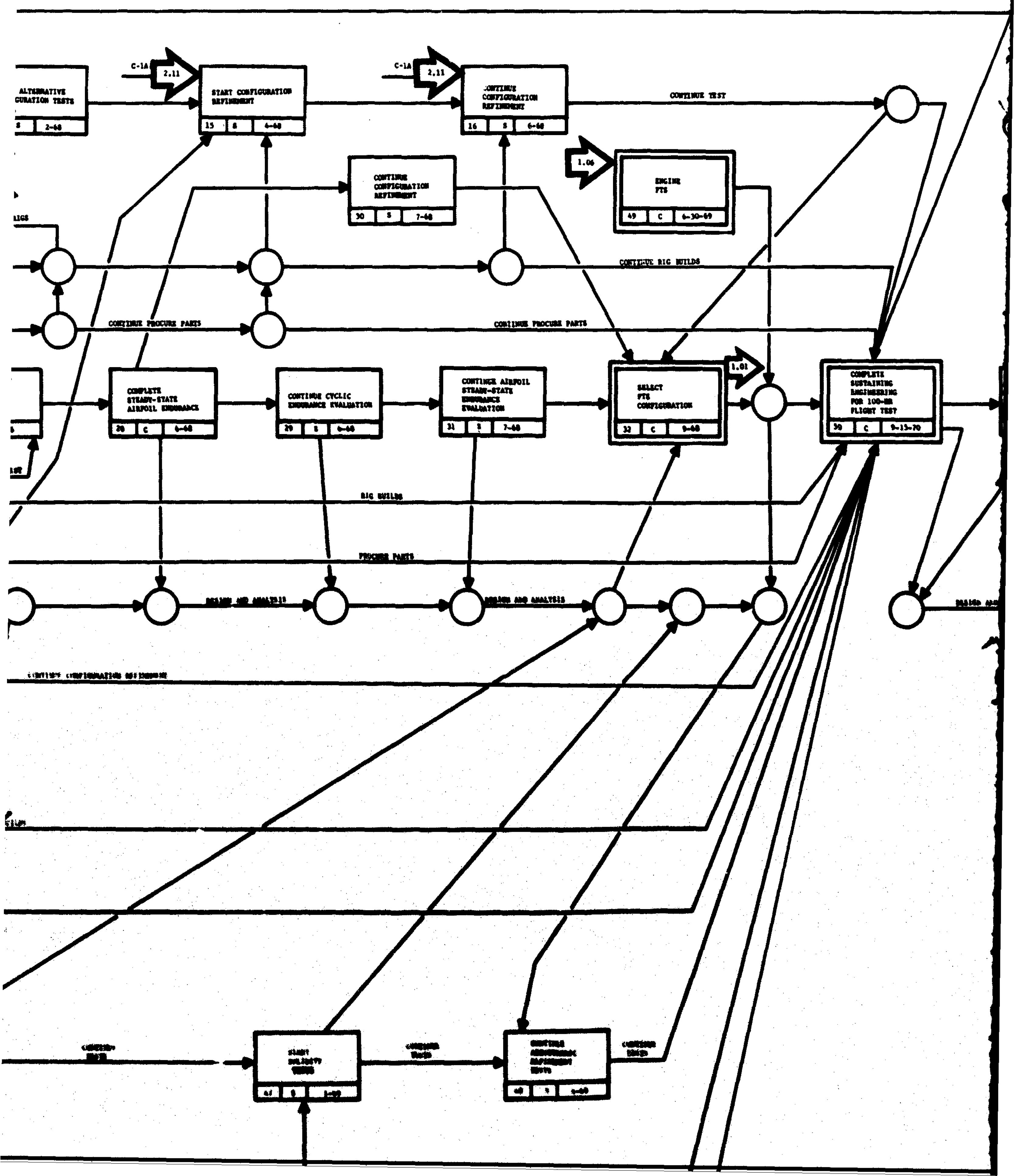


1.01
CONTINUE TESTS
1.19
START DISK LCF TESTS
COMPLETE 1ST-STAGE BLADE TESTS
CONTINUE TESTS
C-1A
2.11
START 1ST-STAGE VANE TESTS
PREPARE FOR TESTS
COMPLETE 1ST-STAGE VANE TESTS
PREPARE FOR TESTS
START 2ND-STAGE BLADE TESTS
PREPARE 1ST -STAGE VANE RIG
PREPARE 2ND-STAGE BLADE RIG
PREPARE 2ND-STAGE VANE RIG
CONTINUE PROCURE PARTS
START HEAT TRANSFER TESTS OF AIRFOILS
COMPLETE HEAT TRANSFER TESTS
SEA LEVEL
START STRUCTURAL TESTS
COMPLETE STRUCTURAL TESTS
START CYCLIC ENDURANCE OF AIRFOILS
PREPARE PARTS FOR TEST
HIGH SPOOL RIG BUILDS
CONTINUE RIG BUILDS
INSTRUMENTATION
1.06
PROCURE PARTS
DESIGN AND ANALYSIS
A-11
START LCF TEST OF ALTERNATIVE CONFIGURATION
CONTINUE RIG BUILDS

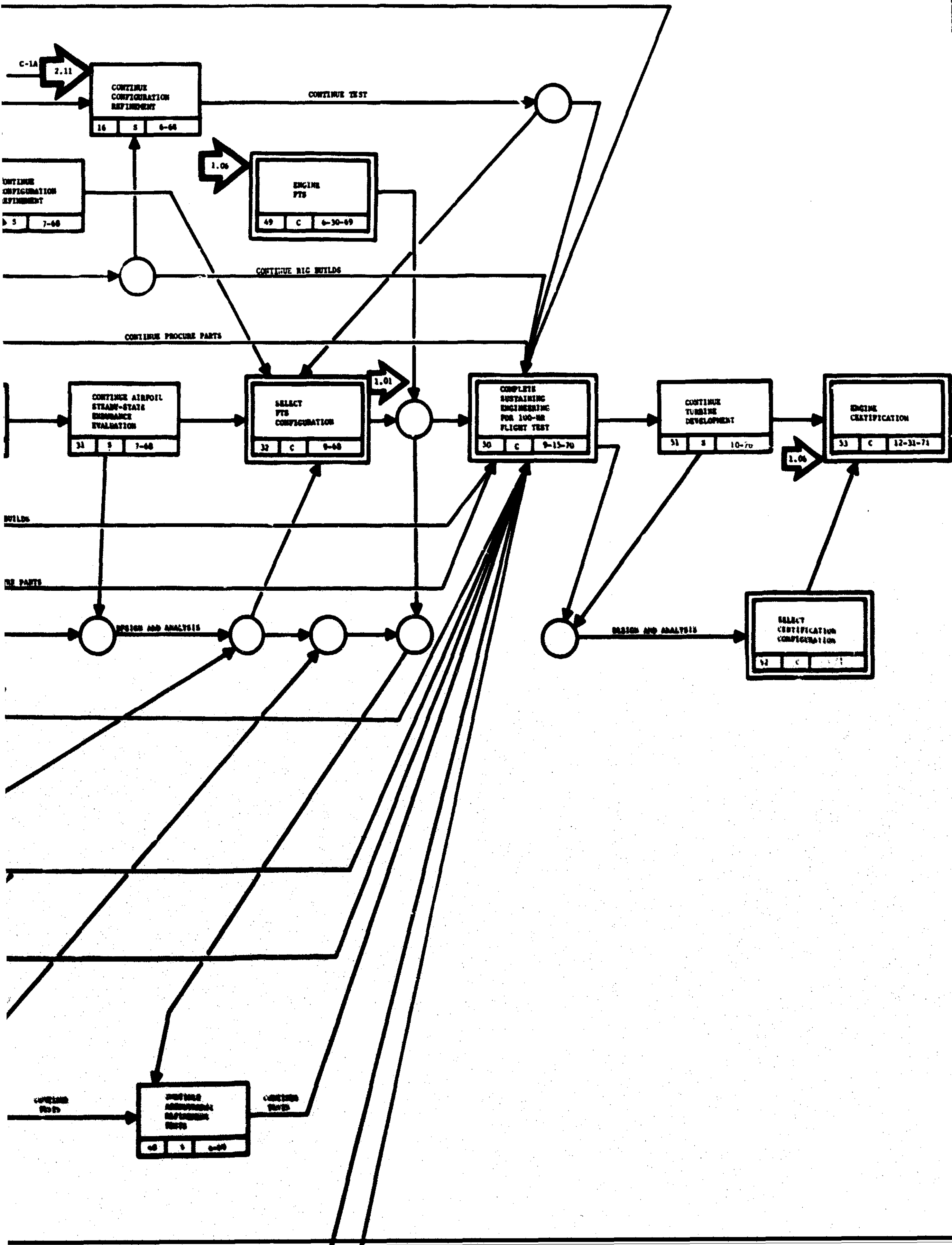
1.13 Turbine


CONTINUE TESTING
CONTINUE TESTS
COMPLETE 2ND-STAGE BLADE TESTS
11 C 11-67
10-67
CONTINUE TEST
C-1A
2.11
START ALTERNATIVE CONFIGURATION TESTS
14 S 2-68
START 2ND-STAGE VANE TESTS
12 S 12-67
COMPLETE 2ND - STAGE VANE TEST
13 C
PREPARE 2ND-VANE RIG
2ND-STAGE VANE RIG
PREPARE RIGS
CONTINUE RIG BUILDS
CONTINUE PROCURE PARTS
SEA LEVEL
START CYCLIC ENDURANCE OF AIRFOILS
23 S 10-67
COMPLETE CYCLIC ENDURANCE OF AIRFOILS
24 C 2-68
START COOLING AIR CIRCUIT EVALUATION
25 S 3-68
COMPLETE COOLING AIR CIRCUIT EVALUATION
26 C 3-68
START AIRFOIL STEADY STATE ENDURANCE TEST
27 S 4-68
COMPLETE STEADY-STATE AIRFOIL END
28 C
PREPARE PARTS FOR TEST
CONTINUE RIG BUILDS
RIG BUILDS
PROCURE PARTS
AND ANALYSIS
CONTINUE TESTS
START CONFIGURATION REFINEMENT
30 S 4-68
PREPARE PARTS FOR TEST

4


C-1A
2.11
ALTERNATIVE
CURATION TESTS
2-68
START CONFIGURATION
REFINEMENT
15
S
6-68
C-1A
2.11
CONTINUE
CONFIGURATION
REFINEMENT
16
S
6-68
CONTINUE TEST
CONTINUE
CONFIGURATION
REFINEMENT
30
S
7-68
1.06
ENGINE
FTS
49
C
6-30-69
CONTINUE RIG BUILDS
CONTINUE PROCURE PARTS
CONTINUE PROCURE PARTS
COMPLETE
STEADY-STATE
AIRFOIL ENDURANCE
28
C
6-68
CONTINUE CYCLIC
ENDURANCE EVALUATION
29
S
6-68
CONTINUE AIRFOIL
STEADY-STATE
ENDURANCE
EVALUATION
31
S
7-68
SELECT
FTS
CONFIGURATION
32
C
9-68
1.01
COMPLETE
SUSTAINING
ENGINEERING
FOR 100-HR
FLIGHT TEST
50
C
9-15-70
RIG BUILDS
PROCURE PARTS
DESIGN AND ANALYSIS
DESIGN AND ANALYSIS

5


C-1A
2.11
CONTINUE CONFIGURATION REFINEMENT
16 S 6-68
CONTINUE TEST
1.06
ENGINE FTS
49 C 6-30-69
CONTINUE RIG BUILDS
CONTINUE PROCURE PARTS
CONTINUE AIRFOIL STEADY-STATE ENDURANCE EVALUATION
31 S 7-68
SELECT FTS CONFIGURATION
32 C 9-68
1.01
COMPLETE SUSTAINING ENGINEERING FOR 100-HR FLIGHT TEST
30 C 9-15-70
CONTINUE TURBINE DEVELOPMENT
51 S 10-70
ENGINE CERTIFICATION
53 C 12-31-71
1.06
DESIGN AND ANALYSIS
SELECT CERTIFICATION CONFIGURATION
BUILDS
PARTS

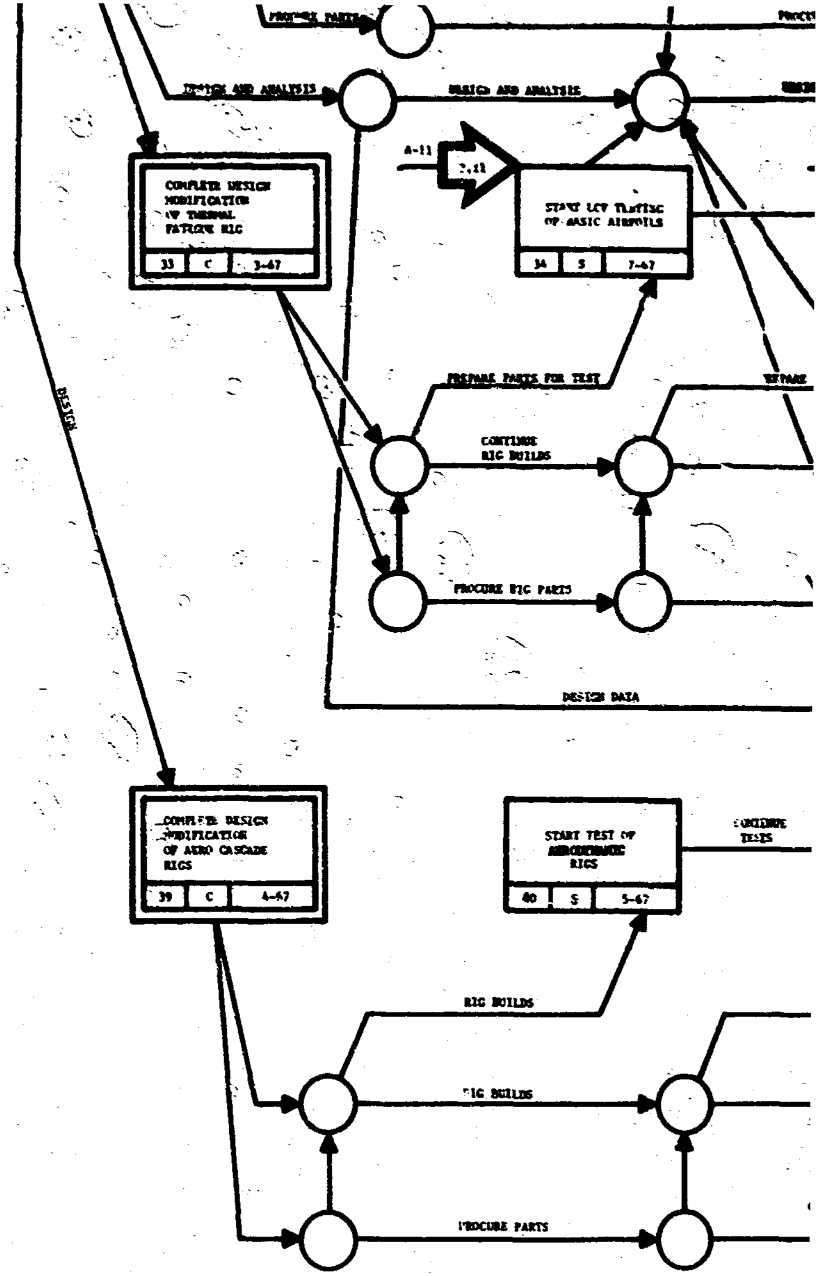


Figure 26. 1.13 Turbine

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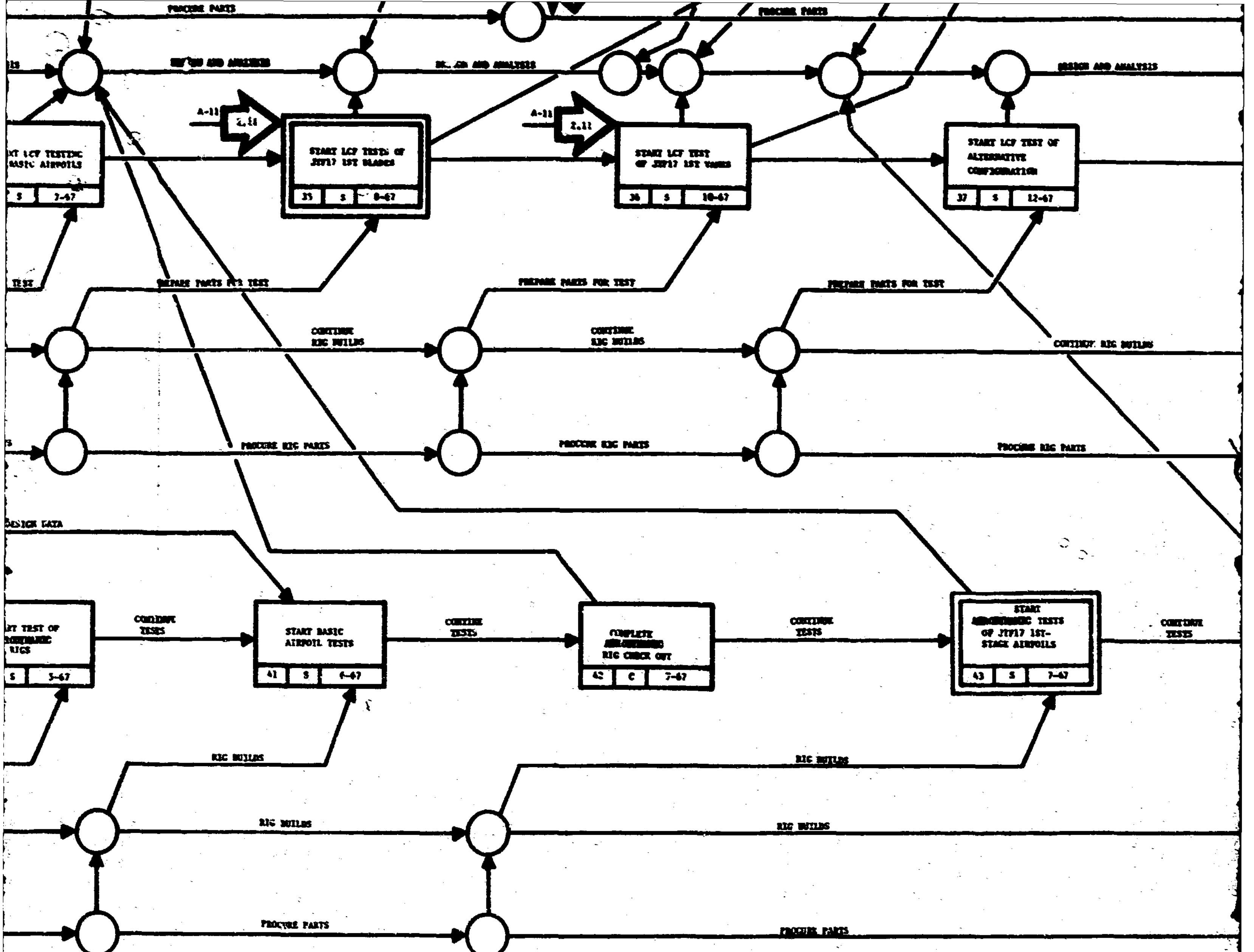

Event Number	Description and Criteria
1	START PHASE III Start Phase III Turbine Development Program. Phase III go-ahead.
2	CONTINUE LABORATORY EROSION AND CORROSION TESTS Continue Phase II-C laboratory erosion and corrosion testing of candidate materials and coatings for JTF17 engine. Laboratory tests in progress.
3	CONTINUE PHASE II-C MATERIALS TESTING Continue Phase II-C materials testing of long term creep and stress rupture properties to refine design curves. Laboratory tests in progress.
4	START DISK LCF TESTS Start LCF testing of turbine disks in "Ferris Wheel" LCF rig to verify design life. Tests in "Ferris Wheel" rig in progress.
5	COMPLETE DESIGN OF HEAT TRANSFER RIG Complete design modifications to existing heat transfer rigs to accommodate JTF17 airfoils. Release drawings to Engineering.
6	START THERMODYNAMIC TESTS OF 1ST STAGE BLADES Start heat transfer tests of 1st stage blades to determine metal temperature, cooling effectiveness and temperature profiles. C-1A stand available. Test of 1st blade in progress.
7	COMPLETE 1ST STAGE BLADE TESTS Complete heat transfer test of 1st stage blade in heat transfer rig. Remove rig from stand.
8	START 1ST STAGE VANE TESTS Start heat transfer testing of 1st stage vane airfoils to determine metal temperatures, cooling effectiveness, and temperature profiles. C-1A stand available. Tests of 1st vanes in progress
9	COMPLETE 1ST STAGE VANE TESTS Complete heat transfer test of 1st stage vanes in heat transfer rig. Remove rig from stand.
10	START 2ND STAGE BLADE TESTS Start heat transfer tests of 2nd stage blades to determine metal temperatures, cooling effectiveness and temperature profile. C-1A stand available. Tests on 2nd blades in progress.
11	COMPLETE 2ND STAGE BLADE TESTS Complete heat transfer test of 2nd stage blade in heat transfer rig. Remove rig from stand.
12	START 2ND STAGE VANE TESTS Start heat transfer testing of 2nd stage vanes to determine metal temperature, cooling effectiveness, and temperature profiles. C-1A stand available. Tests on 2nd vanes in progress.
13	COMPLETE 2ND STAGE VANE TESTS Complete heat transfer test of 2nd stage vanes in heat transfer rig. Remove rig from stand.
14	START ALTERNATIVE CONFIGURATION TESTS Start heat transfer tests of alternative configurations selected as candidates for the JTF17 engines. Tests of alternative airfoils in progress.
15	START CONFIGURATION REFINEMENT TESTS Start heat transfer tests of modified airfoil configuration with predicted improvements in cooling effectiveness, and temperature profiles. Testing of modified configurations in progress.
16	CONTINUE CONFIGURATION REFINEMENT Continue testing of modified configurations with predicted improvements in cooling effectiveness, and temperature profiles. Continue testing of modified configurations.
17	COMPLETE DESIGN OF HIGH SPOOL RIG ADAPTERS Complete the design of inlet and exhaust adapters for the high spool rig. Release drawings to Engineering.
18	START CHECKOUT TESTS OF HIGH SPOOL RIG Start initial test of high spool rig to establish operational characteristics and control requirements for cyclic testing. Initial test of high spool rig.

Event Number	Description and Criteria
19	START Start ther dete of a Heat
20	COMP Comp high
21	START Star and inti
22	COMPL Compl in hi
	START Start to de pect Engin
24	COMPL Compl part
25	START Start of Conl
26	COMPL Comp in th
27	START Star test corr in p

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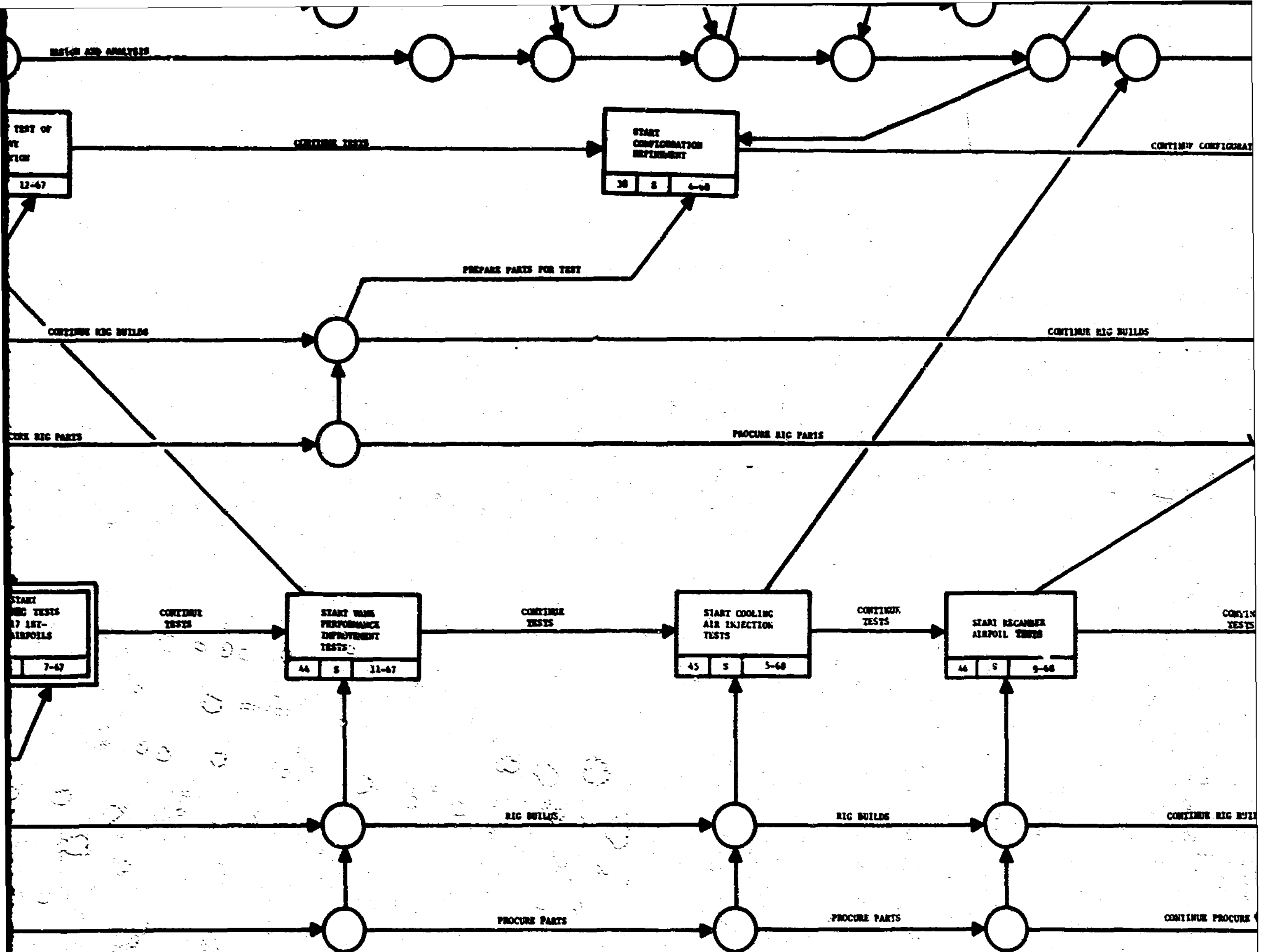
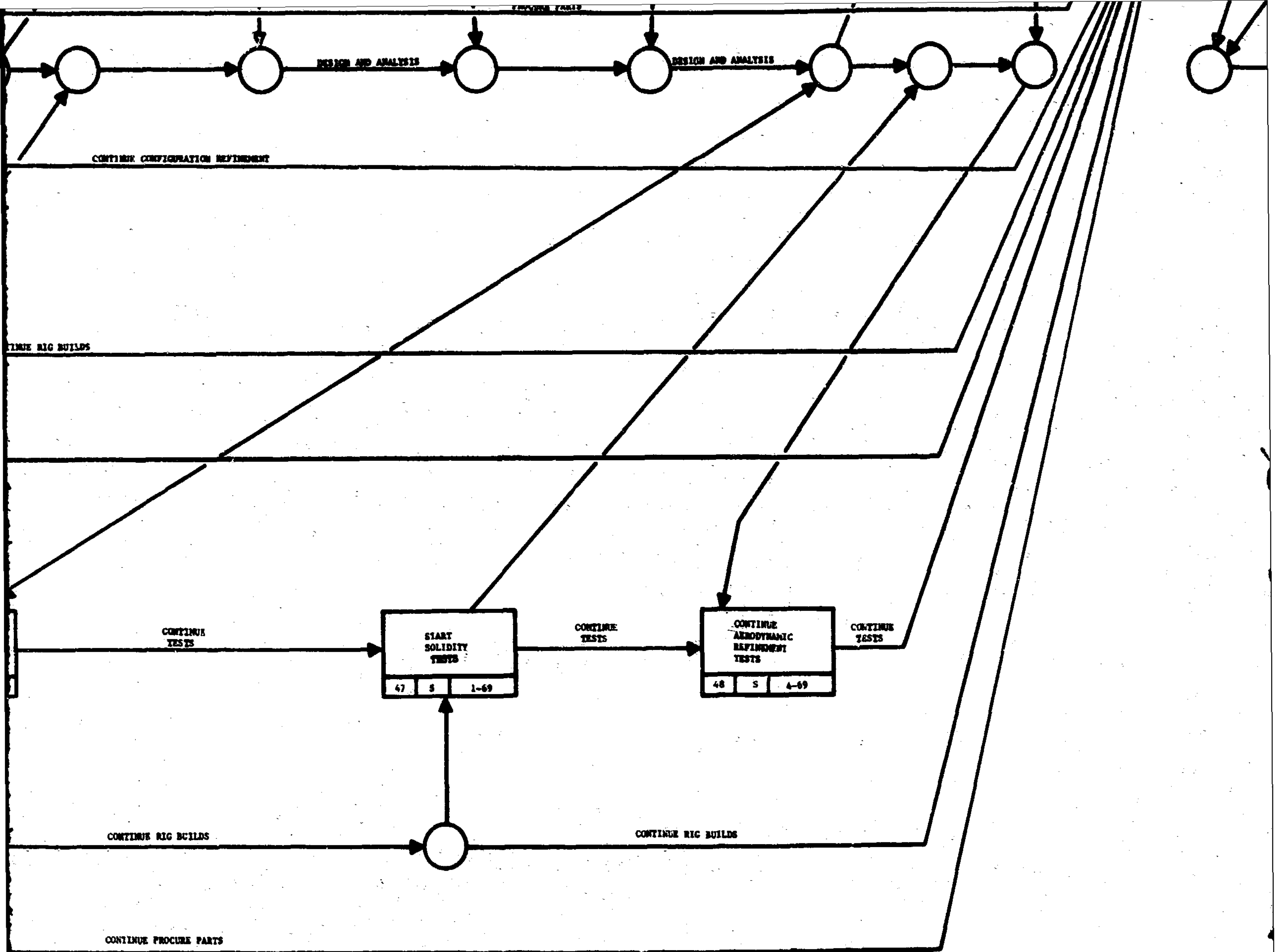


EVENT DICTIONARY
1.13 TURBINE

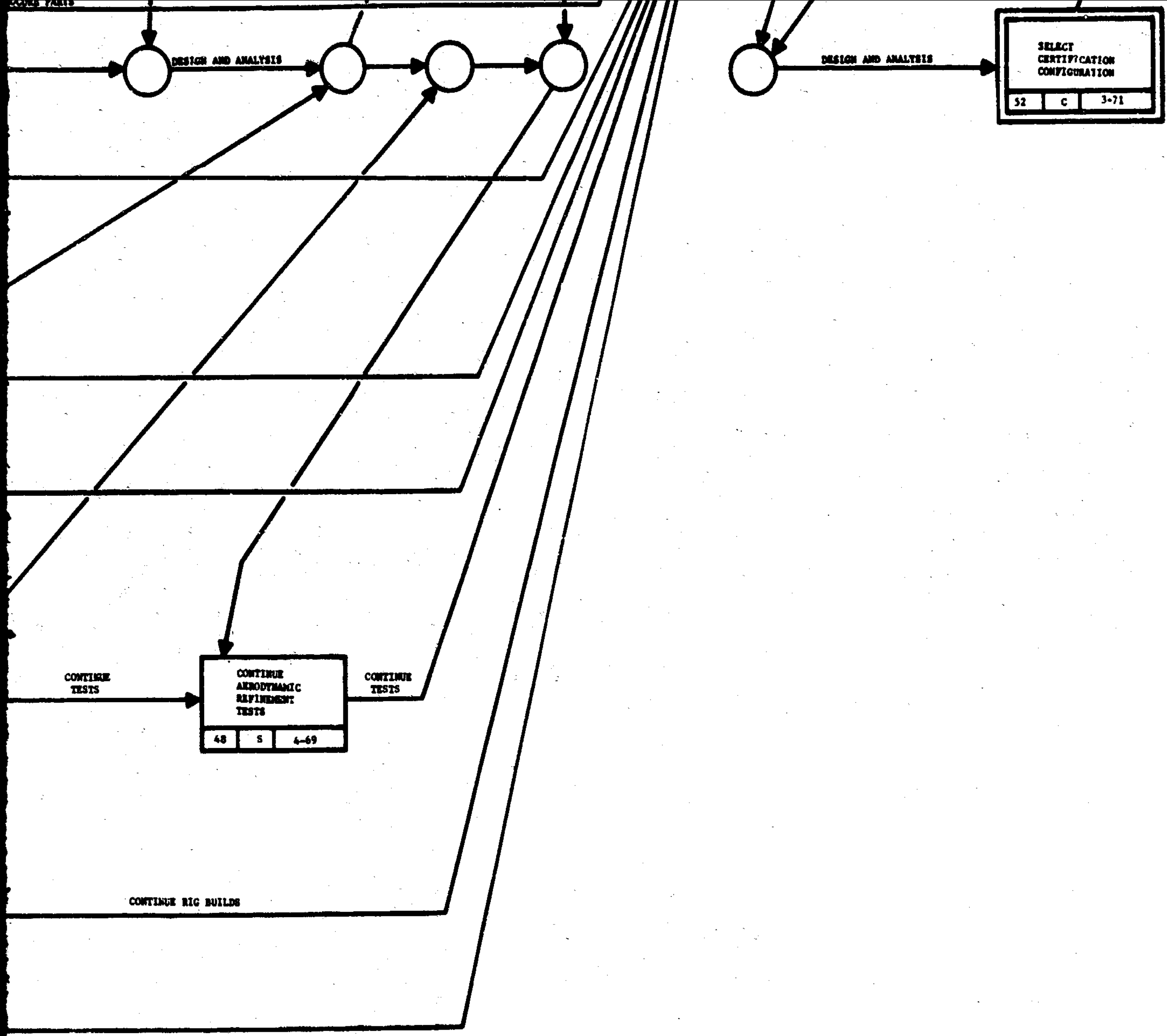
Event Number	Description and Criteria
19	START HEAT TRANSFER TESTS OF AIRFOILS Start heat transfer tests of airfoils to determine thermal gradients during engine accelerations and decelerations and to determine metal temperature of airfoils at simulated cruise conditions. Heat transfer tests of airfoils in progress.
20	COMPLETE HEAT TRANSFER TESTS Complete heat transfer tests of airfoils in the high spool rig. Remove rig from stand.
21	START STRUCTURAL TESTS Start tests of high spool rig to determine disk and blade stress levels and vibratory characteristics. Structural tests in progress.
22	COMPLETE STRUCTURAL TESTS Complete structural tests of blades and disks in high spool rig. Remove rig from stand.
23	START CYCLIC ENDURANCE OF AIRFOILS Start cyclic endurance testing in high spool rig to determine thermal fatigue resistance of hot section parts including 1st stage blades and vanes. Endurance test in progress
24	COMPLETE CYCLIC AIRFOIL ENDURANCE Complete thermal fatigue tests of hot section parts in high spool rig. Remove rig from stand.
25	START COOLING AIR CIRCUIT EVALUATION Start high spool rig tests to determine performance of cooling air system and adequacy of supply. Cooling circuit tests in progress.
26	COMPLETE COOLING AIR CIRCUIT EVALUATION Complete performance tests of cooling air circuit in the high spool rig. Remove rig from stand.
27	START AIRFOIL STEADY-STATE ENDURANCE Start airfoil long term steady-state endurance testing in high spool rig to determine erosion/corrosion resistance of airfoils. Endurance test in progress.
28	COMPLETE STEADY-STATE AIRFOIL ENDURANCE Complete erosion/corrosion tests of airfoils under long term endurance conditions. Remove rig from stand.
29	CONTINUE CYCLIC ENDURANCE EVALUATION Continue thermal fatigue testing of alternative airfoils to develop improved resistance to thermal fatigue. Cyclic testing in progress.
30	CONTINUE CONFIGURATION REFINEMENT Continue high spool rig tests to develop refinements in airfoil configurations for improved erosion/corrosion and thermal fatigue resistance. Start high spool testing of modified configurations.
31	CONTINUE AIRFOIL STEADY-STATE ENDURANCE Continue erosion/corrosion testing of airfoils under long term endurance conditions in the high spool rig. Endurance tests in progress.
32	SELECT FTS CONFIGURATION Select airfoil configurations and material/coating systems for incorporation into engine parts list for FTS test. Release drawings to engine parts list.
33	COMPLETE DESIGN OF THERMAL FATIGUE RIG Complete design modifications to existing thermal fatigue rig to accommodate JTF17 airfoils for thermal fatigue evaluations. Release drawings.
34	START LCF TESTING ON BASIC AIRFOILS Start LCF tests on basic airfoils to checkout rig operation and results of various time cycles. Rig tests in progress.
35	START LCF TESTS OF JTF17 1ST BLADES Start LCF tests of JTF17 1st blade configuration to verify predicted design life. Cycle testing in progress.
36	START LCF TESTS OF JTF17 1ST VANES Start LCF tests of JTF17 1st vane configuration to verify predicted design life. Cycle testing in progress.
37	START LCF TESTS OF ALTE Start LCF tests of alte figurations with predic fatigue capability. Cy
38	START CONFIGURATION REF Start LCF tests on modi with predicted improvem and thermal fatigue p progress.
39	COMPLETE DESIGN OF AERO Complete design of 1st existing annular rig an rig for comparative eva
40	START TESTS OF AERODYNA Start tests of modified performance evaluation,
41	START BASIC AIRFOIL TEST Start performance testi establish baseline perf ability. Rig test in p
42	COMPLETE AERODYNAMIC RI Complete testing requir characteristics of rigs of airfoils. Remove ri
43	START AERODYNAMIC TESTS Start aerodynamic tests design performance pred in progress.
44	START VANE PERFORMANCE I Start aerodynamic perfo vane configurations to d improvement. Aerodynam
45	START COOLING AIR INJECT Start aerodynamic perfor methods of injecting co main stream for minimum test in progress.

8



Description and Criteria
START LCF TESTS OF ALTERNATIVE CONFIGURATIONS Start LCF tests of alternative airfoil configurations with predicted improvements in thermal fatigue capability. Cycle testing in progress.
START CONFIGURATION REFINEMENT Start LCF tests on modified airfoil configurations with predicted improvements in cooling effectiveness and thermal fatigue resistance. Cycle testing in progress.
COMPLETE DESIGN OF AERODYNAMIC CASCADE RIG Complete design of 1st stage test section for existing annular rig and design of plane cascade rig for comparative evaluations. Release drawings.
START TESTS OF AERODYNAMIC RIGS Start tests of modified annular rig for airfoil performance evaluation. Rig test in progress.
START BASIC AIRFOIL TESTS Start performance testing of basic airfoils to establish baseline performance for rig and repeatability. Rig test in progress.
COMPLETE AERODYNAMIC RIG CHECKOUT Complete testing required to establish operating characteristics of rigs and baseline performance of airfoils. Remove rig from stand.
START AERODYNAMIC TESTS OF JTF17 1ST STAGE AIRFOILS Start aerodynamic tests of JTF17 airfoils to verify design performance predictions. Aerodynamic test in progress.
START VANE PERFORMANCE IMPROVEMENT TESTS Start aerodynamic performance tests of various vane configurations to determine performance improvement. Aerodynamic test in progress.
START COOLING AIR INJECTION TESTS Start aerodynamic performance tests to evaluate methods of injecting cooling air into the turbine main stream for minimum loss effects. Aerodynamic test in progress.

Event Number	Description and Criteria
46	**START RECAMBER AIRFOIL TESTS** Start aerodynamic tests to determine performance improvements with recambered airfoils. Aerodynamic test in progress.
47	**START SOLIDITY TESTS** Start aerodynamic tests to determine performance improvement with reduced solidity airfoil arrangements. Aerodynamic test in progress.
48	**CONTINUE AERODYNAMIC REFINEMENT TESTS** Continue aerodynamic tests of airfoils with cooling effectiveness and LCF refinements for improved performance and durability. Aerodynamic test in progress.
49	**ENGINE FTS** Reference engine network 1.06 for description and criteria.
50	**COMPLETE SUSTAINING ENGINEERING FOR 100 HOUR FLIGHT TEST** End of Phase III. Completion of 100 hours of flight testing.
51	**CONTINUE TURBINE DEVELOPMENT** Continue turbine development testing for performance and durability improvements. Rig testing in progress.
52	**SELECT CERTIFICATION CONFIGURATION** Select airfoil designs for certification engine with prescribed performance and durability capabilities. Release airfoil designs to engine parts list.
53	**ENGINE CERTIFICATION** Reference engine network 1.06 for description and criteria.



Description and Criteria

START RECAMBER AIRFOIL TESTS
Start aerodynamic tests to determine performance improvements with recambered airfoils Aerodynamic test in progress.

START SOLIDITY TESTS
Start aerodynamic tests to determine performance improvement with reduced solidity airfoil arrangements. Aerodynamic test in progress.

CONTINUE AERODYNAMIC REFINEMENT TESTS
Continue aerodynamic tests of airfoils with cooling effectiveness and LCF refinements for improved performance and durability. Aerodynamic test in progress.

ENGINE FTS
Reference engine network 1.06 for description and criteria.

COMPLETE SUSTAINING ENGINEERING FOR 100 HOUR FLIGHT TEST
End of Phase III. Completion of 100 hours of flight testing.

CONTINUE TURBINE DEVELOPMENT
Continue turbine development testing for performance and durability improvements. Rig testing in progress.

SELECT CERTIFICATION CONFIGURATION
Select airfoil designs for certification engine with prescribed performance and durability capabilities. Release airfoil designs to engine parts list.

ENGINE CERTIFICATION
Reference engine network 1.06 for description and criteria.

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1.14 AUGMENTOR

The duct heater component program will center around a full-scale rig which is an identical representation of the duct heater portion of the JTF17 engine and will be supplemented by full-scale testing of two sector rigs; an annular 0.6-scale duct diffuser rig; and a water tunnel rig.

The full-scale annular duct heater rig will be tested in the FRDC altitude facility to determine duct heater combustion efficiencies, pressure drop, operating range, durability, and ignition capabilities of the basic design and various modifications. The program for this rig will be coordinated with ignition system development, and ignition system hardware will be tested throughout the program.

A full-scale sector rig equivalent to a 60-degree segment will be tested as a supplement to the full-annular rig and testing will be initiated during the early part of Phase III. This rig and the existing smaller segment rig will be used to aid in selections of designs and programs for the full-annular rig by investigating duct burner efficiencies, pressure drop operating range, durability, and ignition capabilities of various designs and modifications at reduced effort and cost. The rig consists of a 60-degree segment, which can be easily and quickly changed or modified, and has a relatively small airflow requirement. This method for preliminary evaluation has proved very successful in prior J58 testing.

In addition to the test rigs, fuel nozzle bench calibration testing will be done to support the sector rigs and the full-annular rig. This testing will consist of evaluation of various designs for fuel spray pattern, flow rate, pressure drop, and droplet size.

The major milestones, network chart and event dictionary for the augmentor are shown in figures 27 and 28, respectively.

A detailed description of the augmentor development is presented in the Test and Certification Plan, Volume III, Report E, and test planning and integration is presented in Test, Volume IV, Report E.

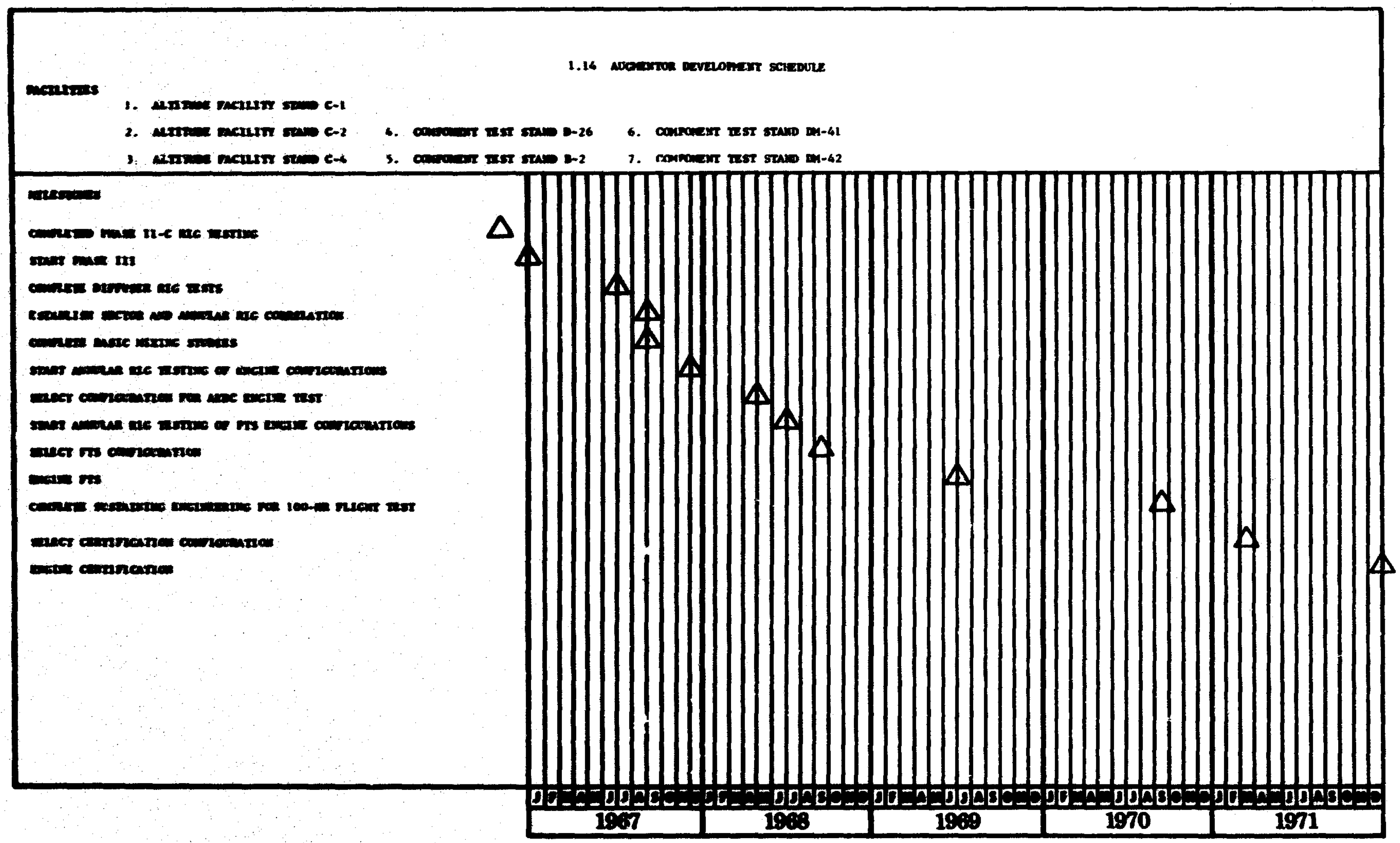

Figure 27. 1.14 Augmentor

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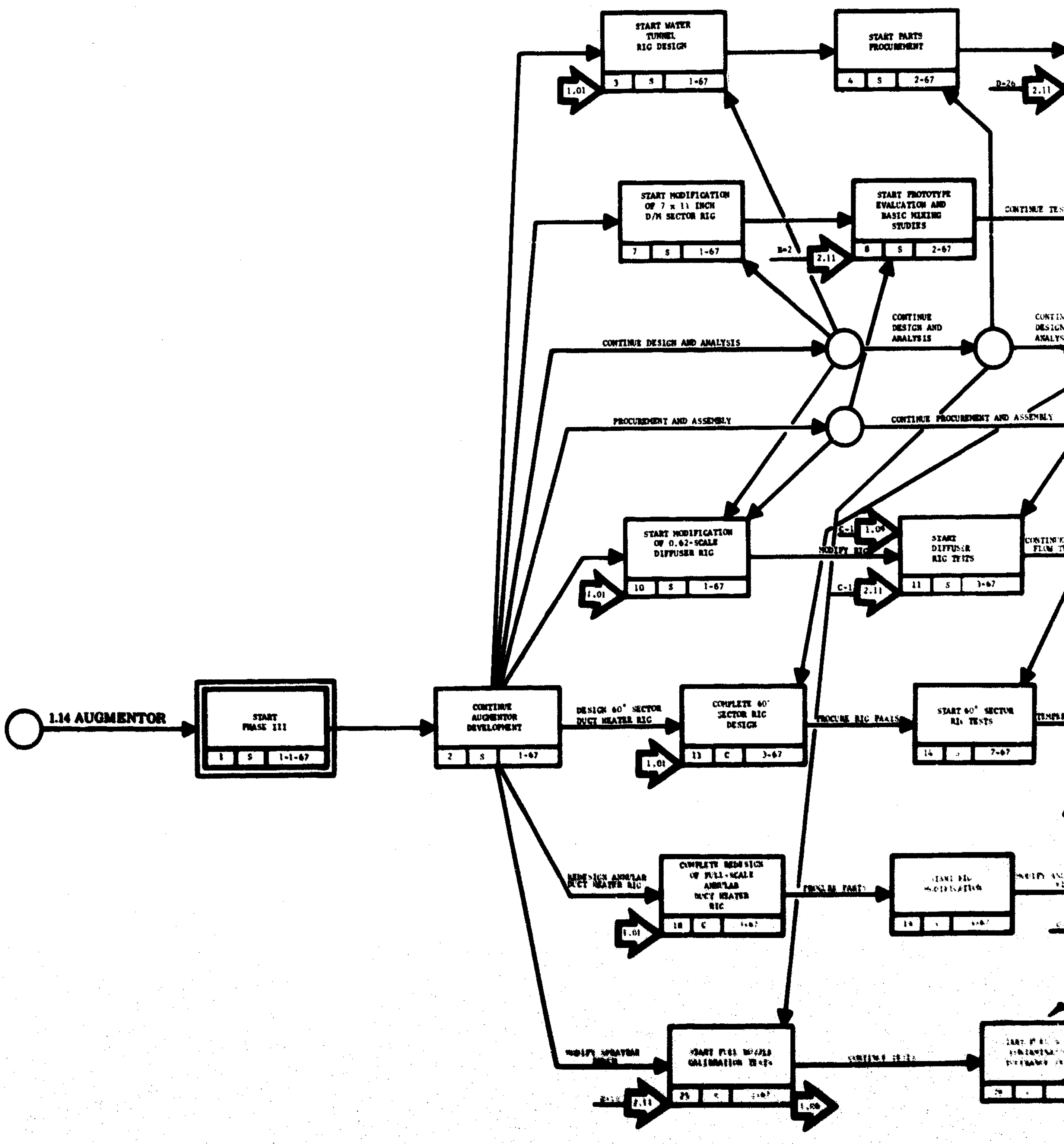
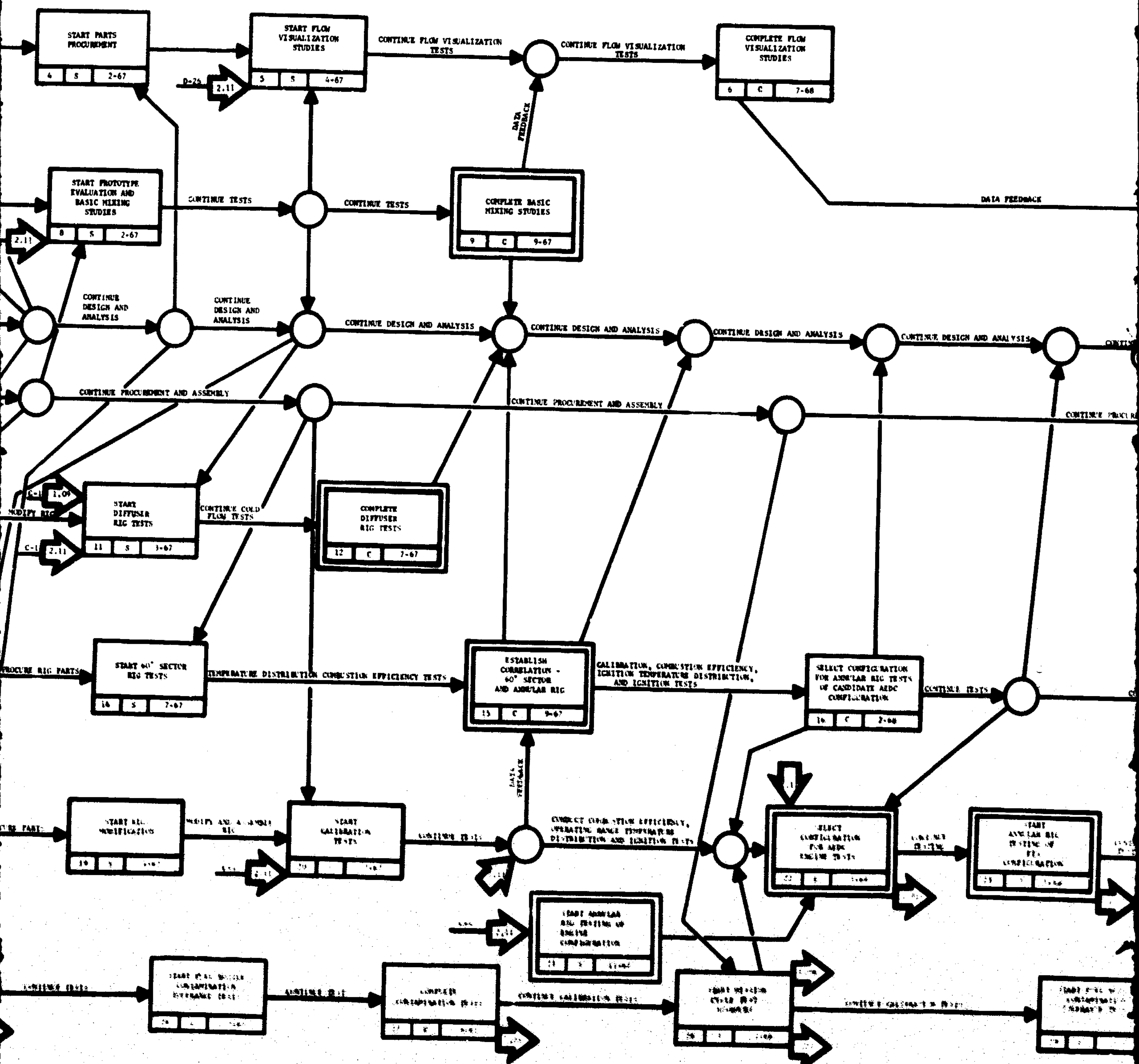
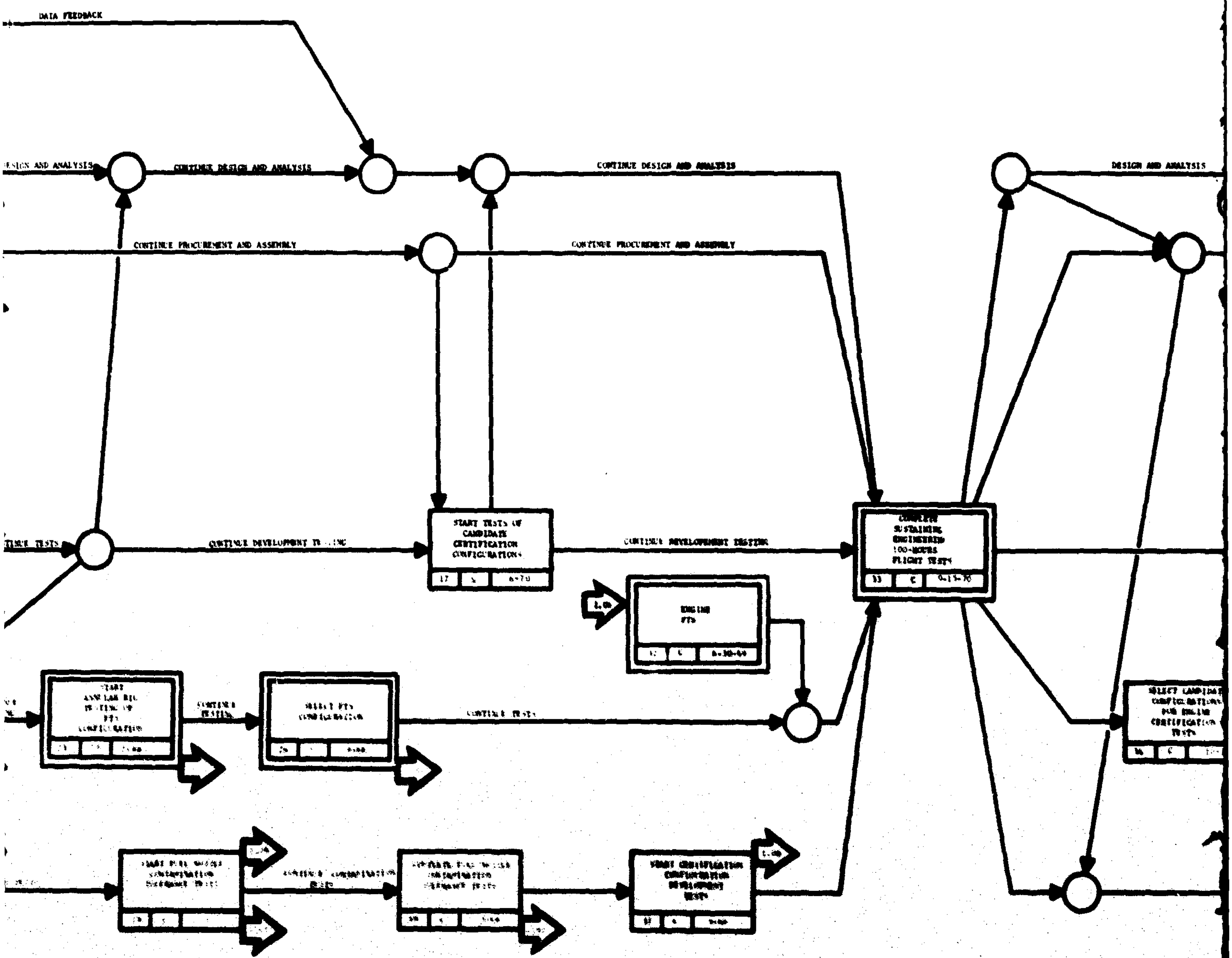


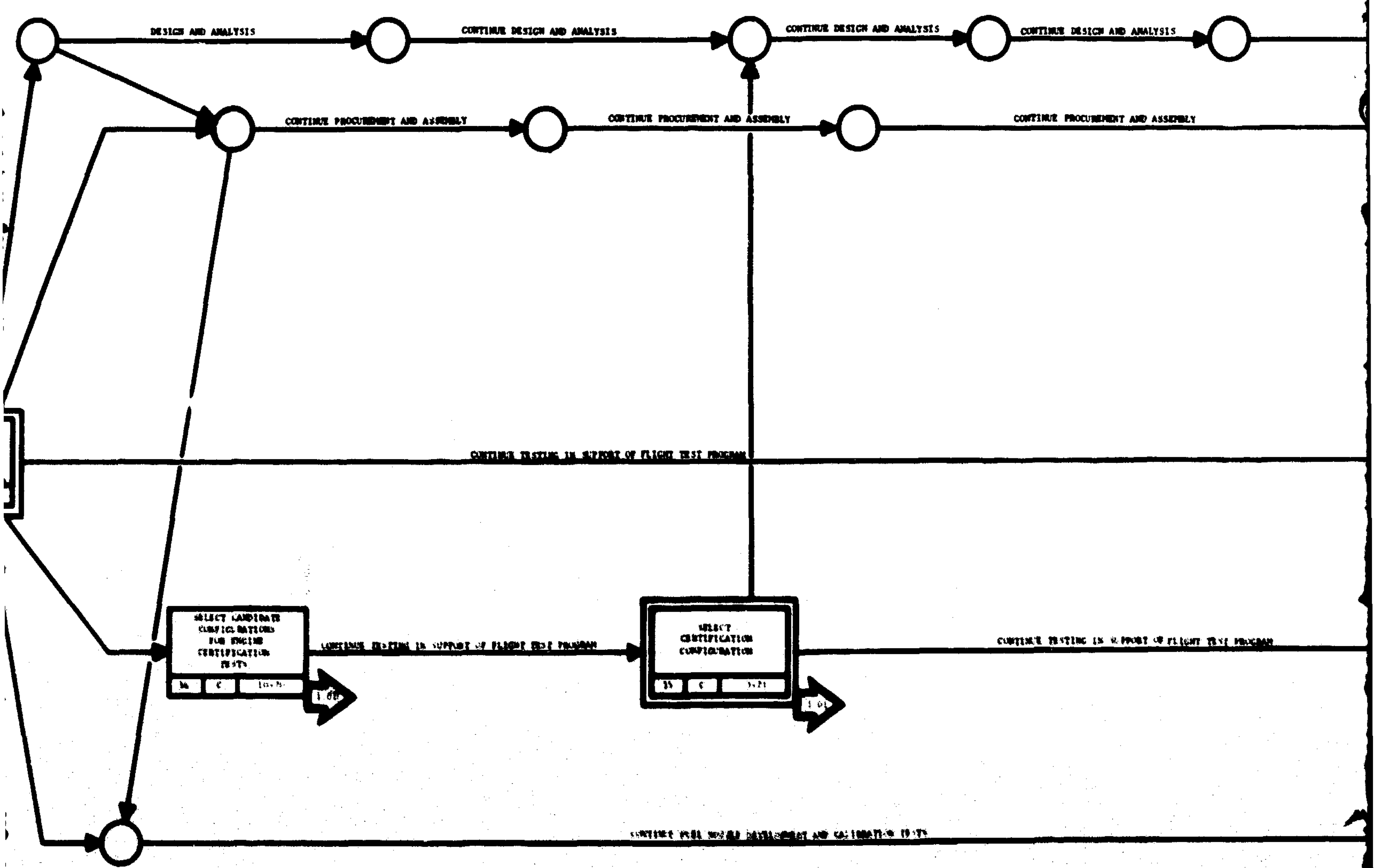
Figure 28. 1.14 Augmentor



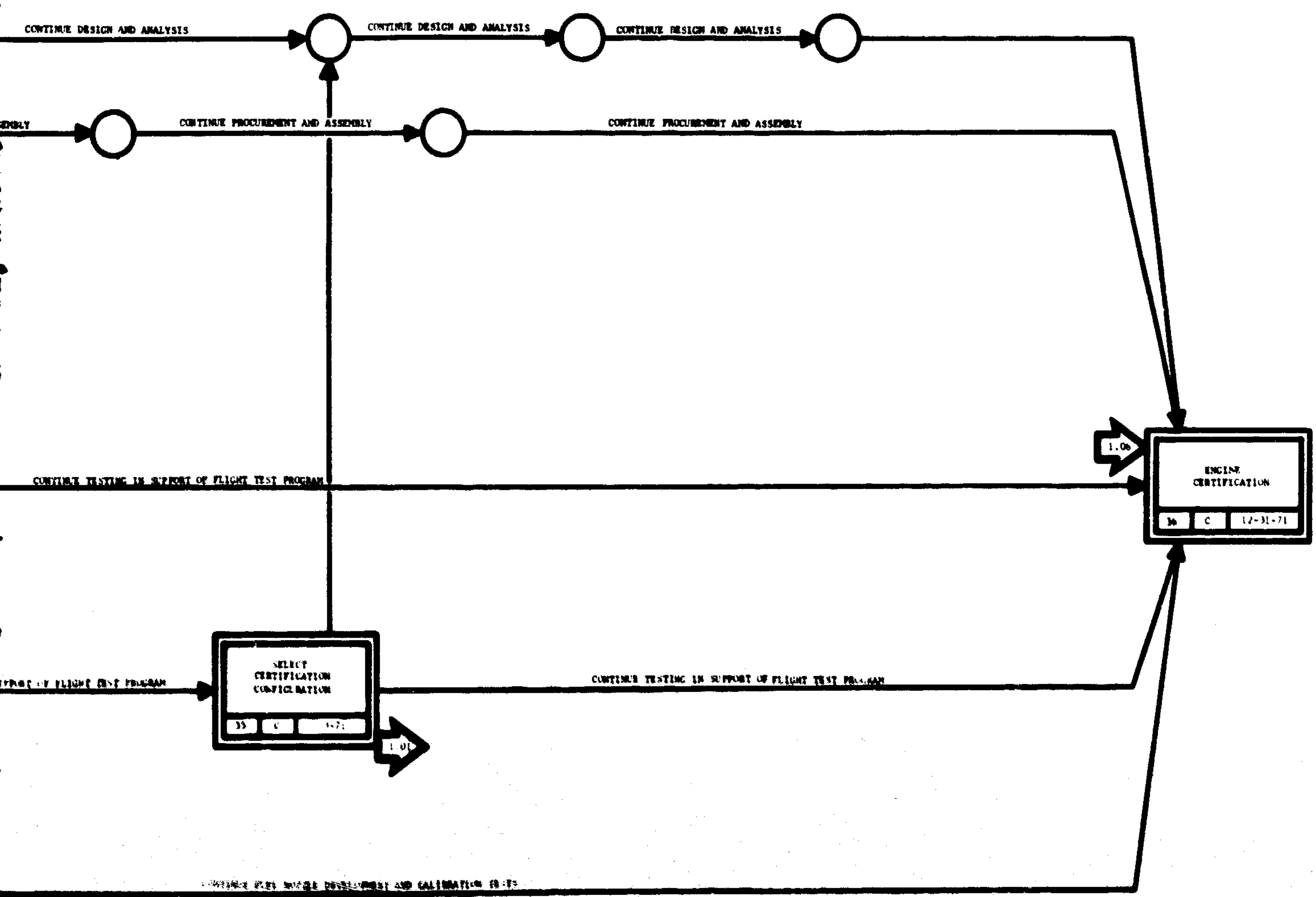
START PARTS PROCUREMENT
4 S 2-67
START FLOW VISUALIZATION STUDIES
5 S 4-67
CONTINUE FLOW VISUALIZATION TESTS
CONTINUE FLOW VISUALIZATION TESTS
COMPLETE FLOW VISUALIZATION STUDIES
6 C 7-68
D-24
2.11
DATA FEEDBACK
START PROTOTYPE EVALUATION AND BASIC MIXING STUDIES
8 S 2-67
CONTINUE TESTS
CONTINUE TESTS
COMPLETE BASIC MIXING STUDIES
9 C 9-67
DATA FEEDBACK
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE PROCUREMENT AND ASSEMBLY
CONTINUE PROCUREMENT AND ASSEMBLY
START DIFFUSER RIG TESTS
11 S 3-67
1.09
2.11
MODIFY RIG
CONTINUE COLD FLOW TESTS
COMPLETE DIFFUSER RIG TESTS
12 C 7-67
PROCURE RIG PARTS
START 60° SECTOR RIG TESTS
14 S 7-67
TEMPERATURE DISTRIBUTION COMBUSTION EFFICIENCY TESTS
ESTABLISH CORRELATION - 60° SECTOR AND ANNULAR RIG
15 C 9-67
CALIBRATION, COMBUSTION EFFICIENCY, IGNITION TEMPERATURE DISTRIBUTION, AND IGNITION TESTS
SELECT CONFIGURATION FOR ANNULAR RIG TESTS OF CANDIDATE AEDC CONFIGURATION
16 C 2-68
CONTINUE TESTS
DATA FEEDBACK
START RIG MODIFICATION
START CALIBRATION TESTS
CONDUCT COMBUSTION EFFICIENCY, OPERATING RANGE TEMPERATURE DISTRIBUTION AND IGNITION TESTS
SELECT CONFIGURATION FOR AEDC ENGINE TESTS
START ANNULAR RIG TESTING OF ENGINE CONFIGURATION
START ANNULAR RIG TESTING OF FTS CONFIGURATION
CONTINUE TESTS
CONTINUE CALIBRATION TESTS

1.14 Augmentor-Duct Heater




DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE PROCUREMENT AND ASSEMBLY
CONTINUE PROCUREMENT AND ASSEMBLY
CONTINUE PROCUREMENT AND ASSEMBLY
CONTINUE TESTING IN SUPPORT OF FLIGHT TEST PROGRAM
SELECT CANDIDATE CONFIGURATIONS FOR ENGINE CERTIFICATION TESTS
CONTINUE TESTING IN SUPPORT OF FLIGHT TEST PROGRAM
SELECT CERTIFICATION CONFIGURATION
CONTINUE TESTING IN SUPPORT OF FLIGHT TEST PROGRAM

4



CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE PROCUREMENT AND ASSEMBLY
CONTINUE PROCUREMENT AND ASSEMBLY
CONTINUE TESTING IN SUPPORT OF FLIGHT TEST PROGRAM
1.06
ENGINE CERTIFICATION
36
C
12-31-71
SELECT CERTIFICATION CONFIGURATION
35
C
1.06
CONTINUE TESTING IN SUPPORT OF FLIGHT TEST PROGRAM

5

1.15 EXHAUST SYSTEM

Rig and laboratory testing will include load deflection and cyclic testing of all critical portions of the reverser-suppressor. These tests will be conducted on segments of the reverser-suppressor and will encompass structural support members; inner and outer structural skin sections; reverser clamshell structure, pivot points and linkage; exit flap (tail-feathers) structure, seals, hinges and support members; tertiary air doors and reverser door units; secondary air seals and engine attachment members.

The initial objective of the rig and laboratory testing will be to produce failures so that design improvements can be incorporated in subsequent engine hardware. The final objective will be to demonstrate the adequacy of these improvements before engine endurance and certification testing begins.

Model testing will be continued, in support of the above hardware testing, to explore means of further improving ejector and reverser performance and achieve increased noise suppression ability.

Performance models will be tested in the United Aircraft Corporation Research Laboratories wind tunnel facilities.

Integration of the exhaust system with the aircraft is a vital consideration in achieving overall performance levels. Experience has shown that installation effects on internal ejector performance are most significant in the transonic flight region when the tertiary air doors are open. At cruise conditions when the tertiary air doors are closed, the internal ejector performance is virtually insensitive to the aircraft local flow field. However, the external performance, such as nacelle drag, is always affected by aircraft flow field, especially if the exhaust system is canted relative to the remainder of the nacelle. For these reasons the scale model testing at United Aircraft Corporation Research Laboratories will include reverser-suppressor installation performance testing to evaluate these effects.

Noise suppression models will be tested in the FRDC jet noise test stand, and results from this testing will be used to establish the full-scale program. Full-scale engine noise suppression work will be done in conjunction with reverser development testing on a JTF17 engine test stand.

The major milestones, network chart and event dictionary for the exhaust system are shown in figures 29 and 30, respectively.

A detailed description of the exhaust system development is presented in the Test and Certification Plan, Volume III, Report E, and test planning and integration is presented in Test, Volume IV, Report E.

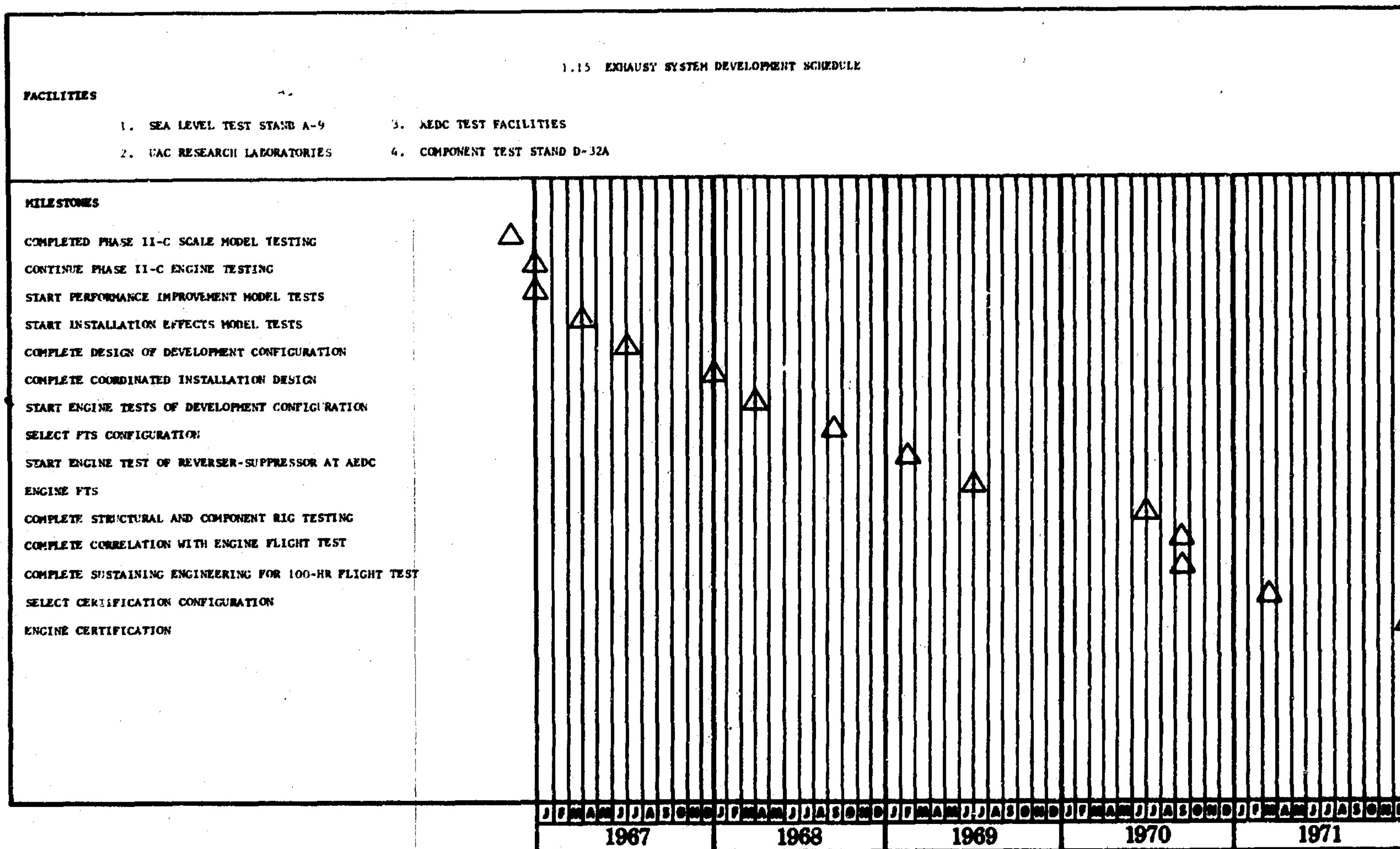


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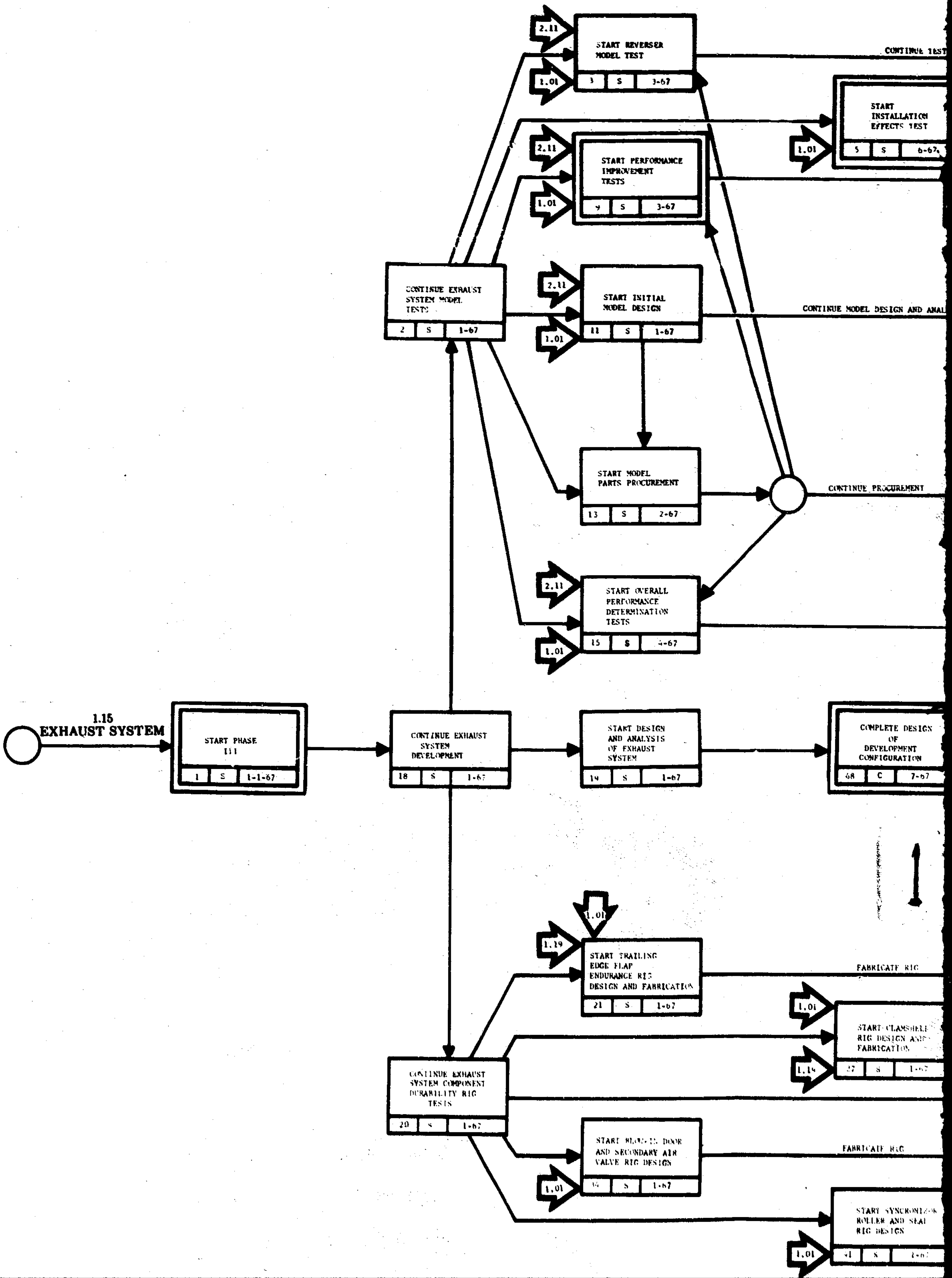
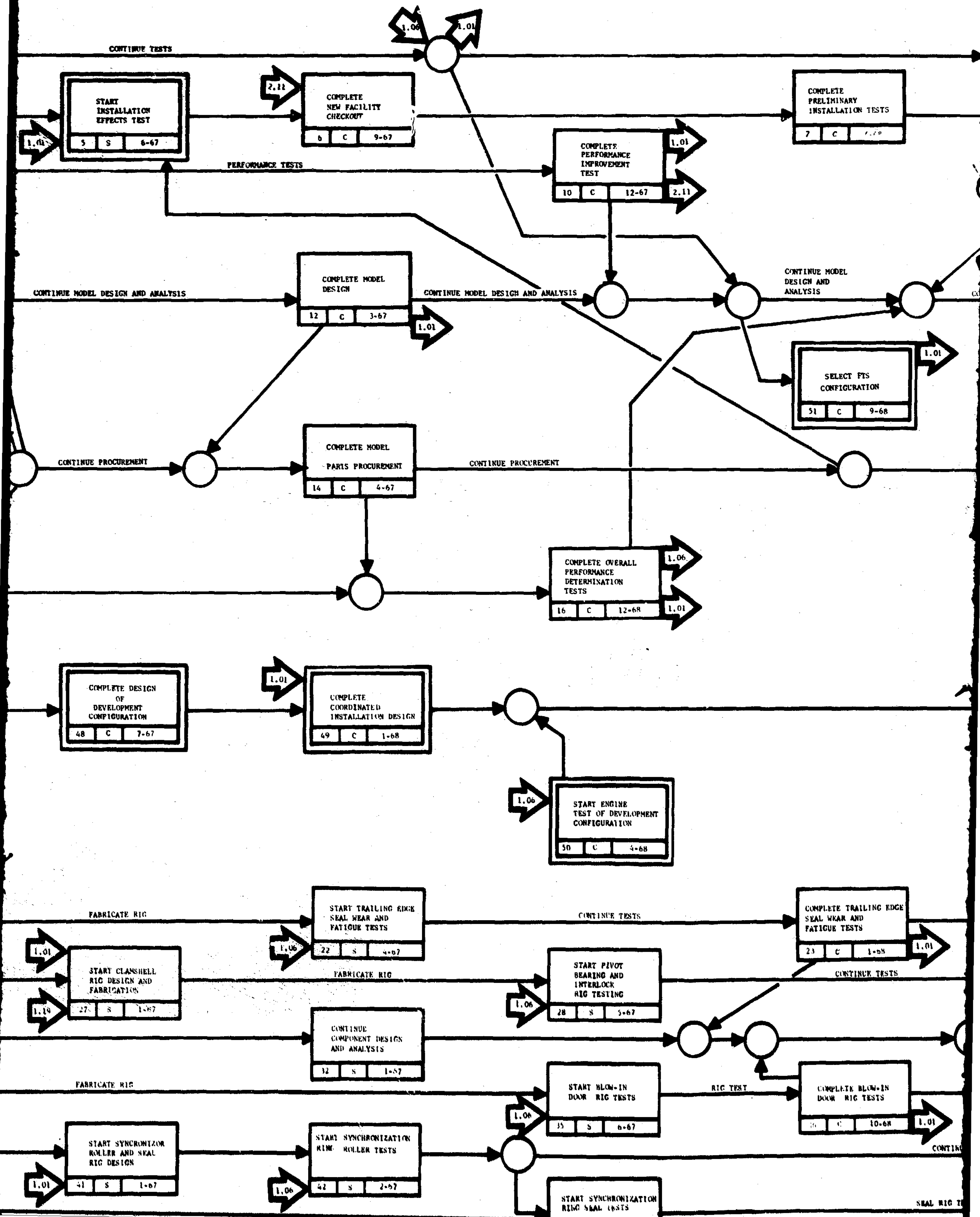
Figure 29. 1.15 Exhaust System


1.15
EXHAUST SYSTEM
START PHASE III
1 S 1-1-67
CONTINUE EXHAUST SYSTEM DEVELOPMENT
18 S 1-67
CONTINUE EXHAUST SYSTEM MODEL TESTS
2 S 1-67
2.11
1.01
START REVERSER MODEL TEST
3 S 3-67
CONTINUE TEST
START INSTALLATION EFFECTS TEST
5 S 6-67
START PERFORMANCE IMPROVEMENT TESTS
9 S 3-67
START INITIAL MODEL DESIGN
11 S 1-67
CONTINUE MODEL DESIGN AND ANAL
START MODEL PARTS PROCUREMENT
13 S 2-67
CONTINUE PROCUREMENT
START OVERALL PERFORMANCE DETERMINATION TESTS
15 S 4-67
START DESIGN AND ANALYSIS OF EXHAUST SYSTEM
19 S 1-67
COMPLETE DESIGN OF DEVELOPMENT CONFIGURATION
68 C 7-67
1.19
START TRAILING EDGE FLAP ENDURANCE RIG DESIGN AND FABRICATION
21 S 1-67
FABRICATE RIG
CONTINUE EXHAUST SYSTEM COMPONENT DURABILITY RIG TESTS
20 S 1-67
START AND SECONDARY AIR VALVE RIG DESIGN
1-67
FABRICATE RIG
S

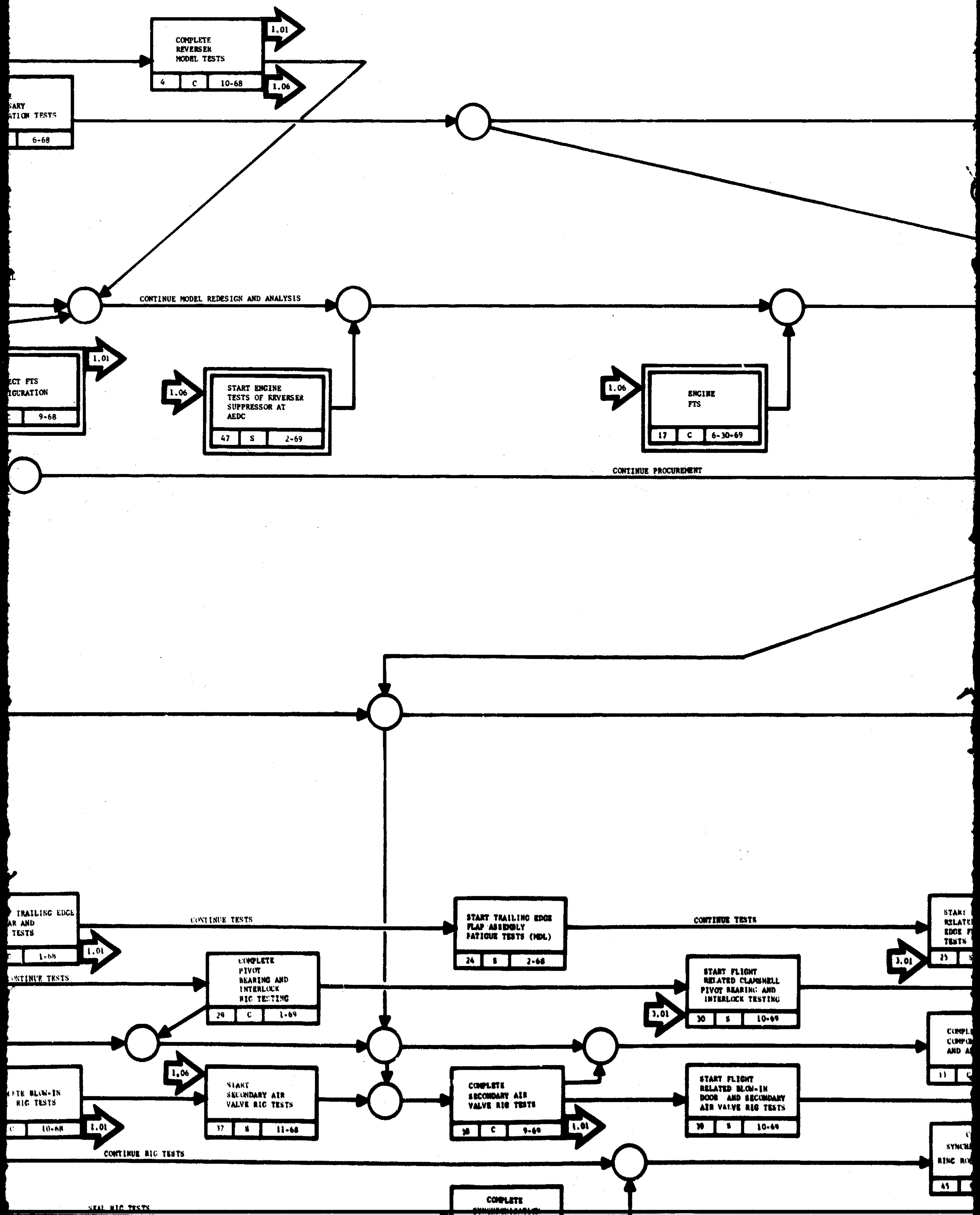
12

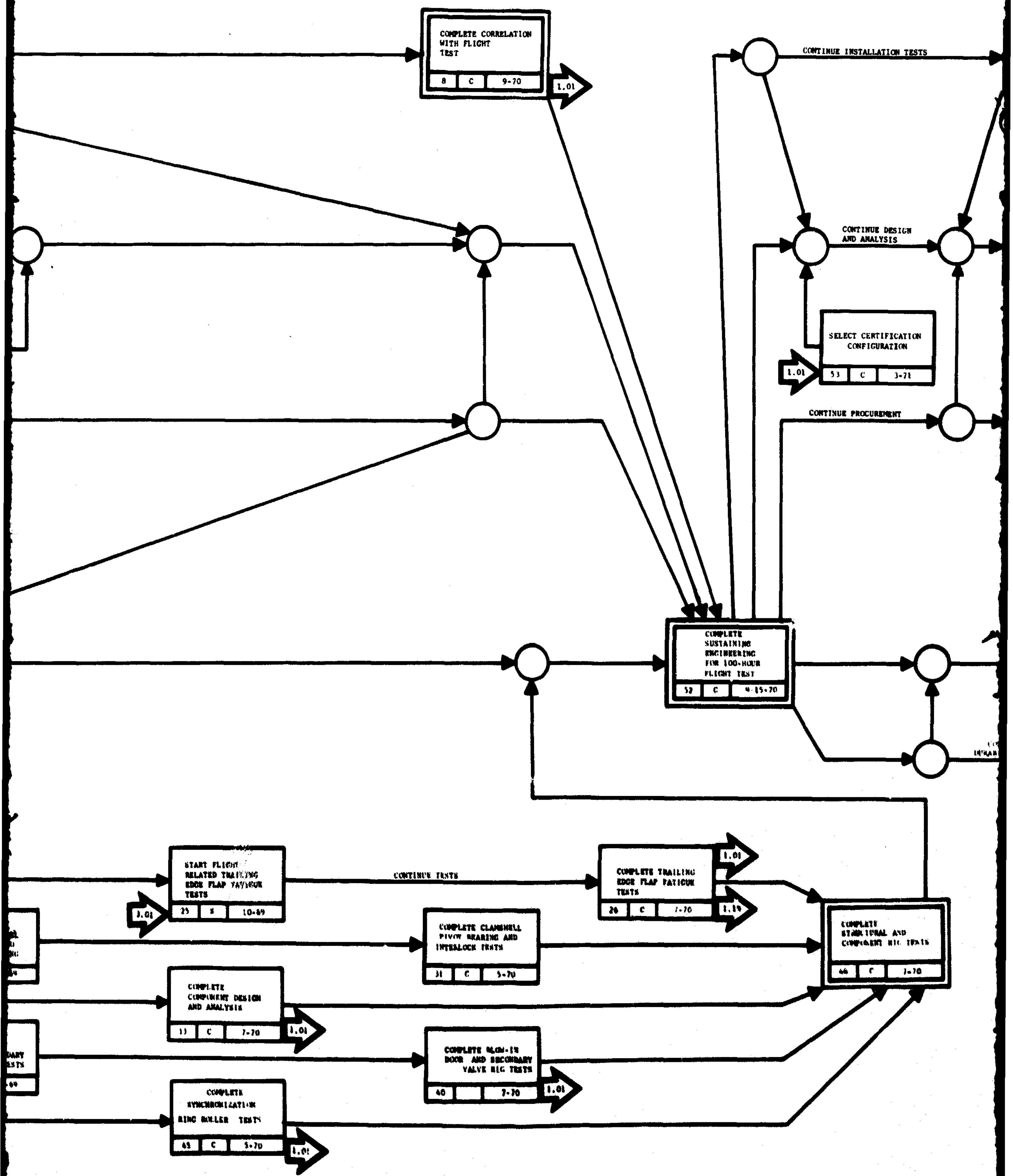
1.15



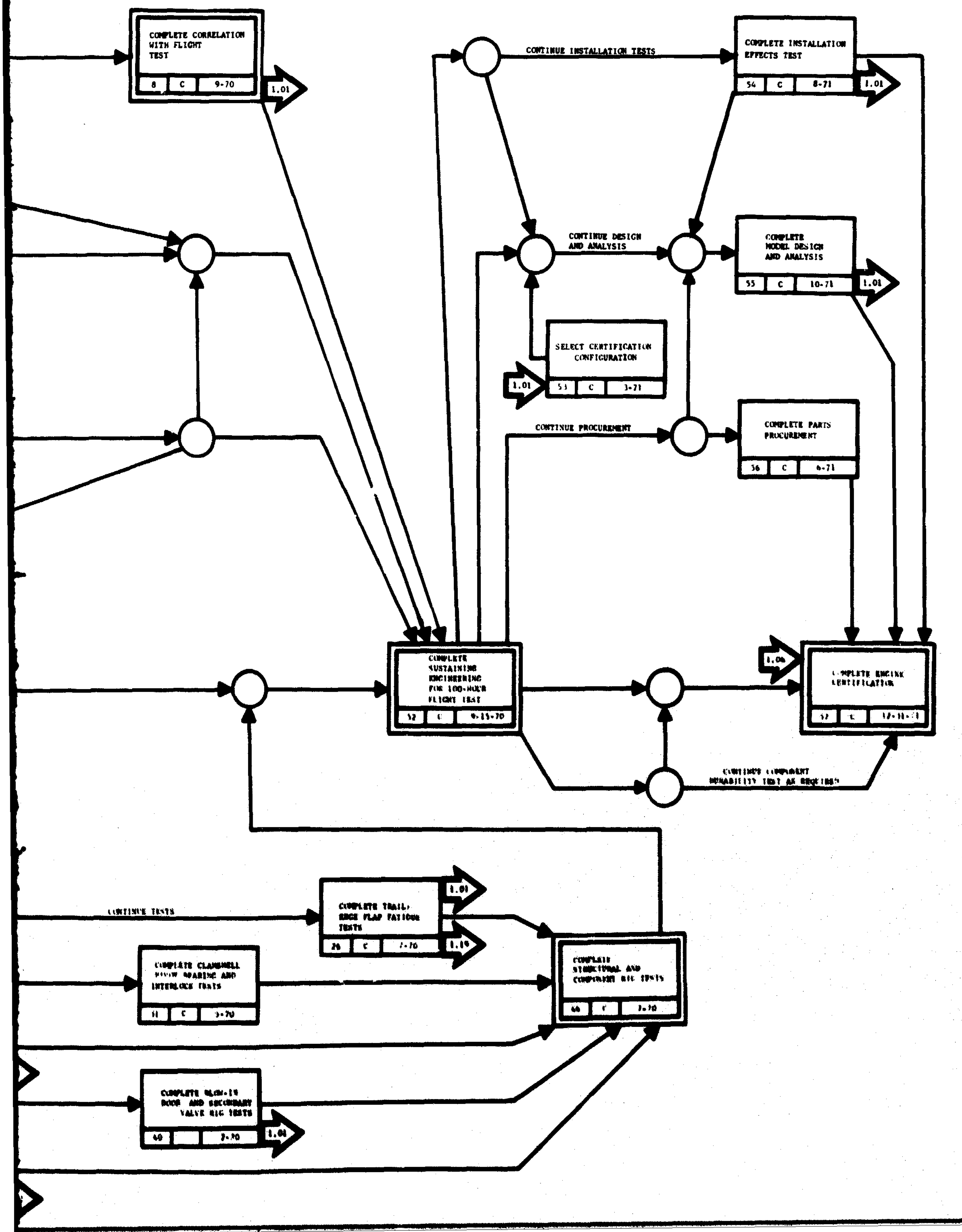
1.06
1.01
CONTINUE TESTS
2.11
START INSTALLATION EFFECTS TEST
5 S 6-67
COMPLETE NEW FACILITY CHECKOUT
6 C 9-67
COMPLETE PRELIMINARY INSTALLATION TESTS
7 C
PERFORMANCE TESTS
COMPLETE PERFORMANCE IMPROVEMENT TEST
10 C 12-67
1.01
2.11
COMPLETE MODEL DESIGN
12 C 3-67
1.01
CONTINUE MODEL DESIGN AND ANALYSIS
CONTINUE MODEL DESIGN AND ANALYSIS
CONTINUE MODEL DESIGN AND ANALYSIS
SELECT FTS CONFIGURATION
51 C 9-68
1.01
CONTINUE PROCUREMENT
COMPLETE MODEL PARTS PROCUREMENT
14 C 4-67
CONTINUE PROCUREMENT
COMPLETE OVERALL PERFORMANCE DETERMINATION TESTS
16 C 12-68
1.06
1.01
COMPLETE DESIGN OF DEVELOPMENT CONFIGURATION
48 C 7-67
1.01
COMPLETE COORDINATED INSTALLATION DESIGN
49 C 1-68
1.06
START ENGINE TEST OF DEVELOPMENT CONFIGURATION
50 C 4-68
FABRICATE RIG
START TRAILING EDGE SEAL WEAR AND FATIGUE TESTS
22 S 4-67
1.06
CONTINUE TESTS
COMPLETE TRAILING EDGE SEAL WEAR AND FATIGUE TESTS
23 C 1-68
1.01
1.01
START CLAMSHELL RIG DESIGN AND FABRICATION
27 S 1-67
1.19
FABRICATE RIG
START PIVOT BEARING AND INTERLOCK RIG TESTING
28 S 5-67
1.06
CONTINUE TESTS
CONTINUE COMPONENT DESIGN AND ANALYSIS
32 S 1-67
FABRICATE RIG
START BLOW-IN DOOR RIG TESTS
35 S 6-67
1.06
RIG TEST
COMPLETE BLOW-IN DOOR RIG TESTS
C 10-68
1.01
START SYNCRONIZOR ROLLER AND SEAL RIG DESIGN
41 S 1-67
1.01
START SYNCHRONIZATION RING ROLLER TESTS
42 S 2-67
1.06
START SYNCHRONIZATION RING SEAL TESTS
SEAL RIG TE

1.15 Exhaust System




COMPLETE CORRELATION WITH FLIGHT TEST
8 C 9-70
1.01
CONTINUE INSTALLATION TESTS
CONTINUE DESIGN AND ANALYSIS
SELECT CERTIFICATION CONFIGURATION
1.01
53 C 3-71
CONTINUE PROCUREMENT
COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST
52 C
START FLIGHT RELATED TRAILING EDGE FLAP FATIGUE TESTS
25 10-69
1.01
CONTINUE TESTS
COMPLETE TRAILING EDGE FLAP FATIGUE TESTS
26 C 7-70
1.01
1.19
COMPLETE CLAMSHELL PIVOT BEARING AND INTERLOCK TESTS
31 C 5-70
COMPLETE STRUCTURAL AND COMPONENT RIG TESTS
46 C
COMPLETE COMPONENT DESIGN AND ANALYSIS
11 C 7-70
1.01
COMPLETE BLOW-IN DOOR AND SECONDARY VALVE RIG TESTS
40 7-70
1.01
COMPLETE SYNCHRONIZATION RING ROLLER TESTS
45 C 5-70
1.01

5


COMPLETE CORRELATION WITH FLIGHT TEST
8 C 9-70
1.01
CONTINUE INSTALLATION TESTS
COMPLETE INSTALLATION EFFECTS TEST
54 C 8-71
1.01
CONTINUE DESIGN AND ANALYSIS
COMPLETE MODEL DESIGN AND ANALYSIS
55 C 10-71
1.01
SELECT CERTIFICATION CONFIGURATION
1.01
53 C 3-71
CONTINUE PROCUREMENT
COMPLETE PARTS PROCUREMENT
56 C 6-71
COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST
CONTINUE TESTS
COMPLETE TRAILING EDGE FLAP FATIGUE TESTS
1.01
COMPLETE CLAMSHELL INTERLOCK TESTS
COMPLETE STRUCTURAL AND COMPONENT RIG TESTS
COMPLETE BLOW-IN DOOR AND SECONDARY VALVE RIG TESTS
1.01

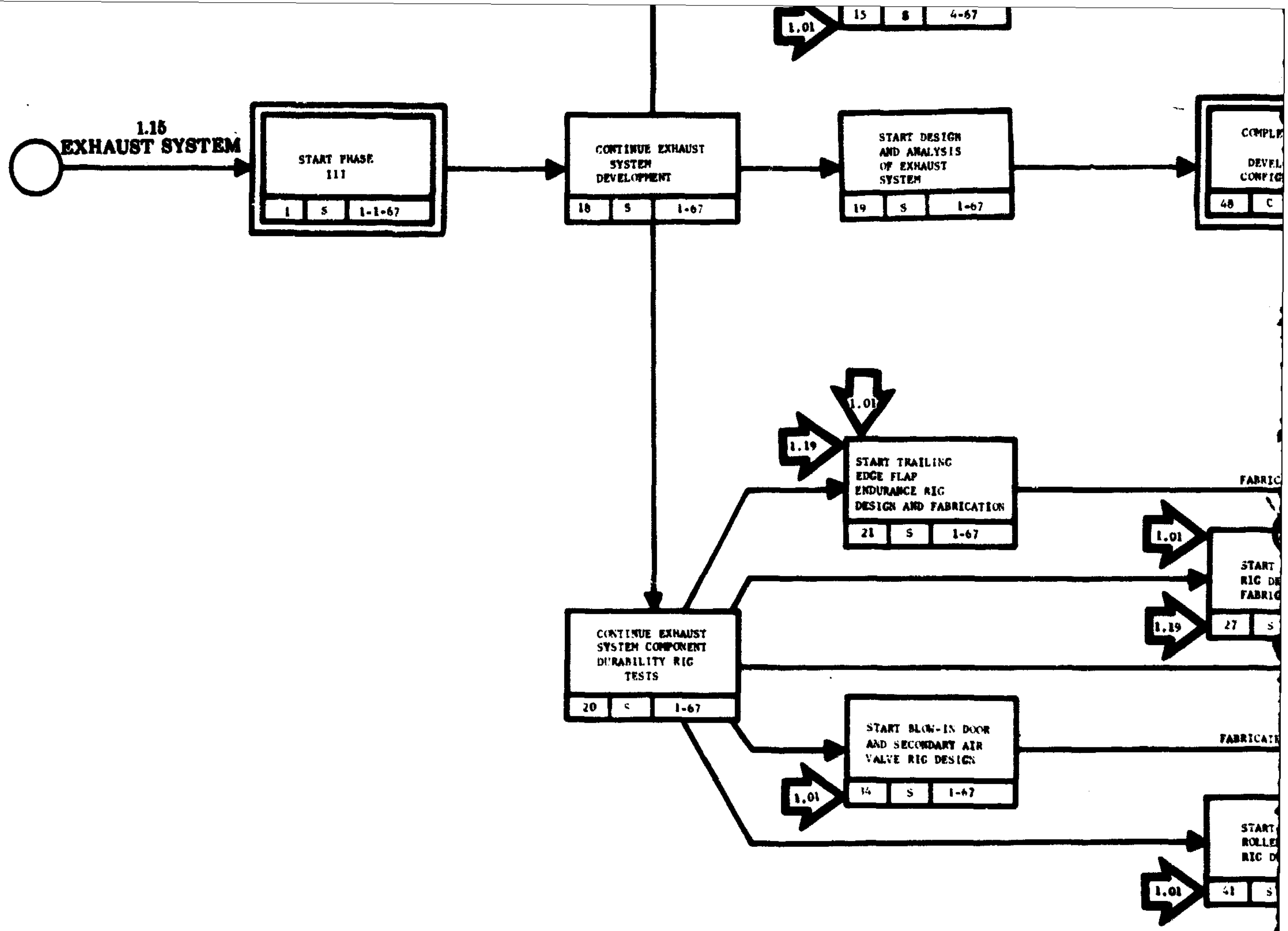
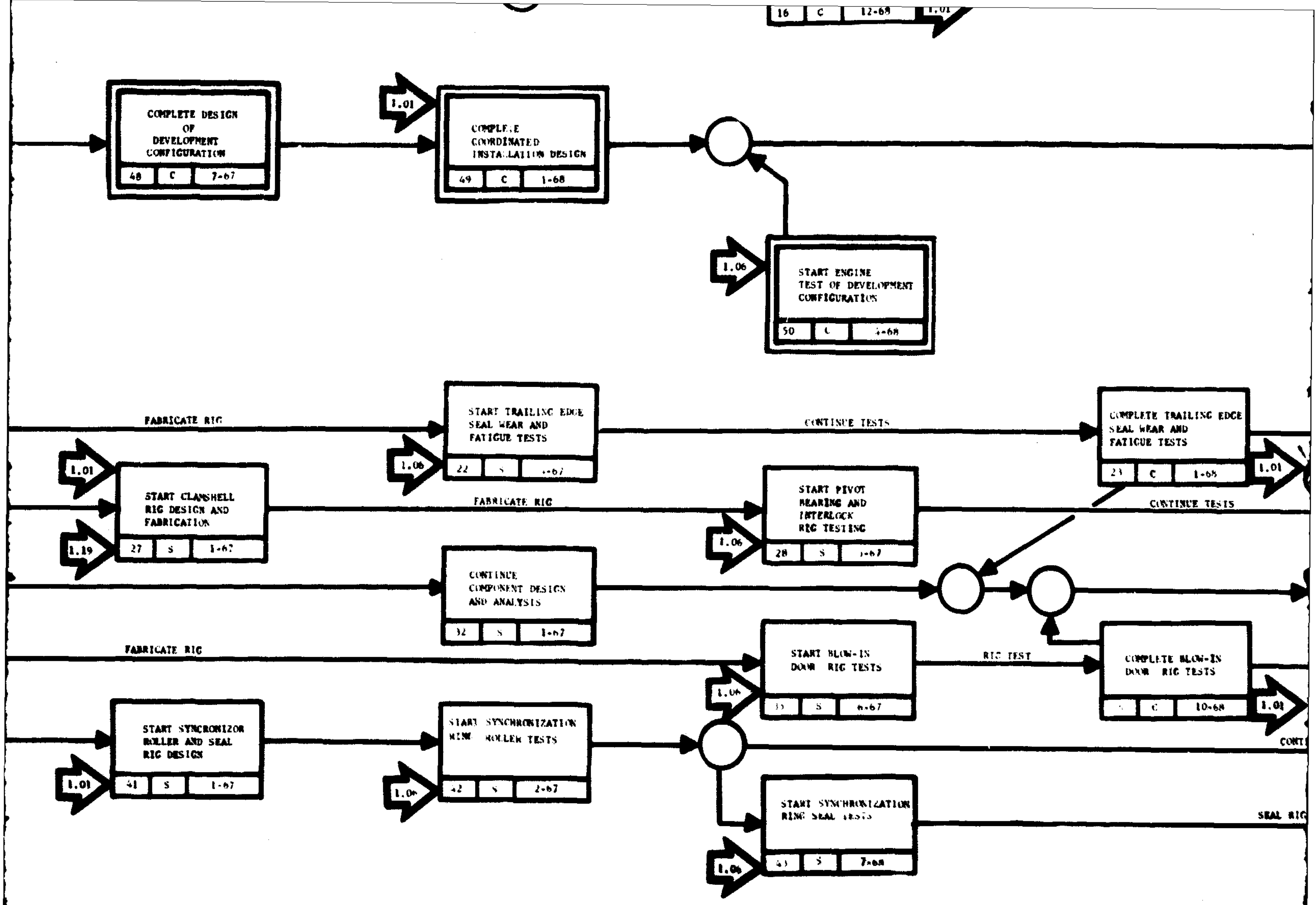


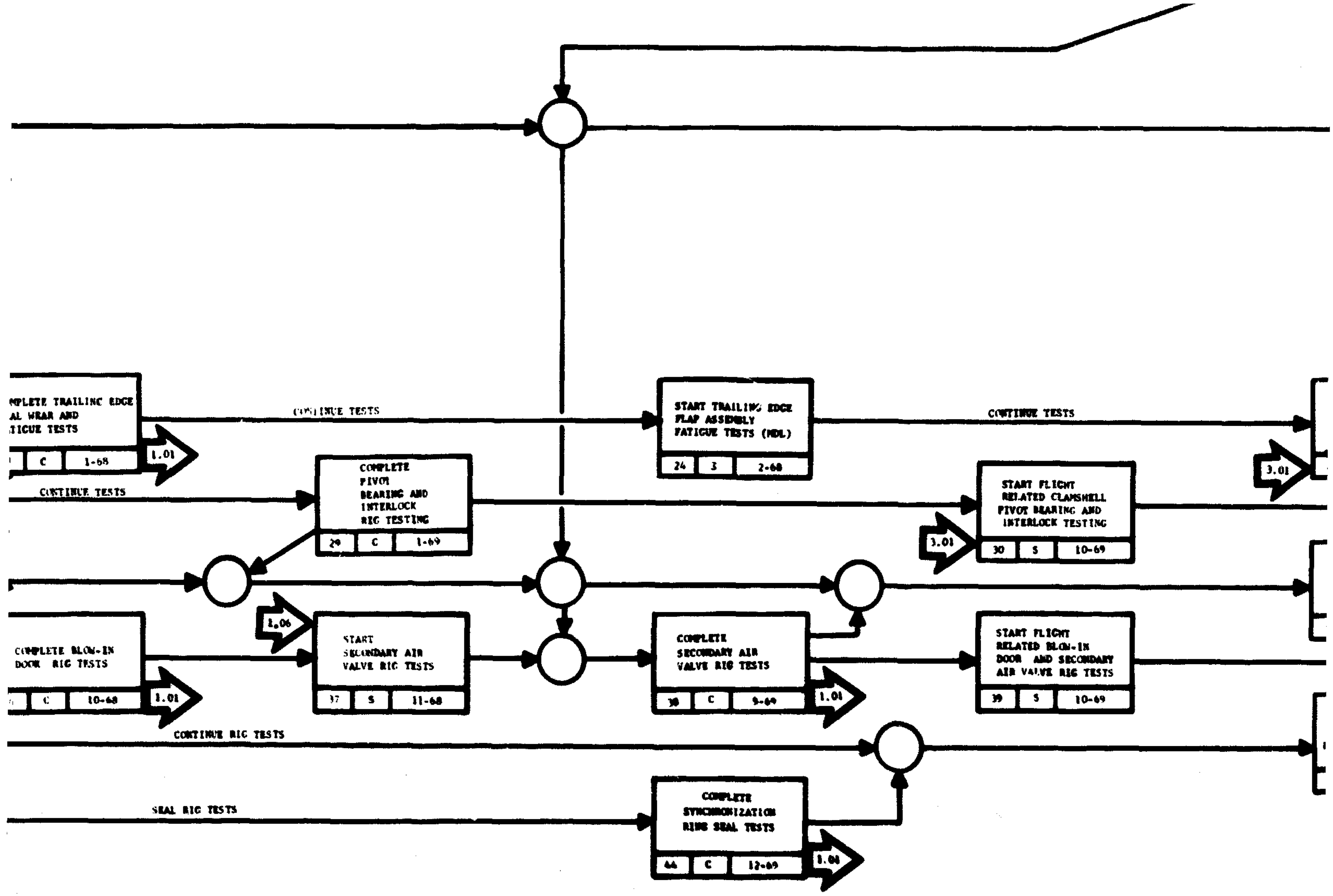
Figure 30. 1.15 Exhaust System

Event Number

1 START PHASE III ... Start of Phase II... from FAA.



Description and Criteria	Event Number	Description and Criteria	Event Number	Description and Criteria
START PHASE III Start of Phase III. Phase III [illegible] received [illegible] FAA.	12	MODEL DESIGN [illegible]	[illegible]	START TRAILING EDGE FLAP SEAL [illegible] TESTS [illegible]
CONTINUE EXHAUST SYSTEM MODEL TESTS [illegible]	[illegible]	START MODEL PARTS PROCUREMENT [illegible]	[illegible]	COMPLETE TRAILING EDGE FLAP [illegible] TESTS [illegible]
START REVERSER MODEL TESTS [illegible]	[illegible]	COMPLETE MODEL PARTS PROCUREMENT [illegible]	[illegible]	START TRAILING EDGE FLAP [illegible] [illegible]
COMPLETE REVERSER MODEL TESTS [illegible]	[illegible]	START OVERALL PERFORMANCE DETERMINATION [illegible]	[illegible]	START FLIGHT RELATED TRAILING [illegible] TESTS [illegible]
START INSTALLATION EFFECTS MODEL TESTS [illegible]	[illegible]	COMPLETE OVERALL PERFORMANCE DETERMINATION [illegible]	[illegible]	COMPLETE TRAILING EDGE FLAP [illegible] [illegible]
COMPLETE FACILITY CHECKOUT [illegible]	[illegible]	ENGINE PTS [illegible]	[illegible]	START CLAMSHELL RIG DESIGN AND [illegible] [illegible]
COMPLETE PRELIMINARY INSTALLATION TESTS [illegible]	[illegible]	CONTINUE EXHAUST SYSTEM DEVELOPMENT [illegible]	[illegible]	START PIVOT BEARING AND INTERLOCK [illegible] [illegible]
COMPLETE CORRELATION WITH FLIGHT TEST [illegible]	[illegible]	START DESIGN AND ANALYSIS OF EXHAUST SYSTEM [illegible]	[illegible]	COMPLETE PIVOT BEARING AND INTERLOCK [illegible] [illegible]
START PERFORMANCE IMPROVEMENT TESTS [illegible]	[illegible]	CONTINUE EXHAUST SYSTEM COMPONENT RELIABILITY RIG TESTS [illegible]	[illegible]	START FLIGHT RELATED CLAMSHELL AND INTERLOCK TESTING [illegible]
COMPLETE PERFORMANCE IMPROVEMENT TESTS [illegible]	[illegible]	START TRAILING EDGE FLAP ENDURANCE RIG DESIGN AND FABRICATION [illegible]		COMPLETE CLAMSHELL PIVOT BEARING [illegible] TESTS [illegible]
START MODEL DESIGN [illegible]				



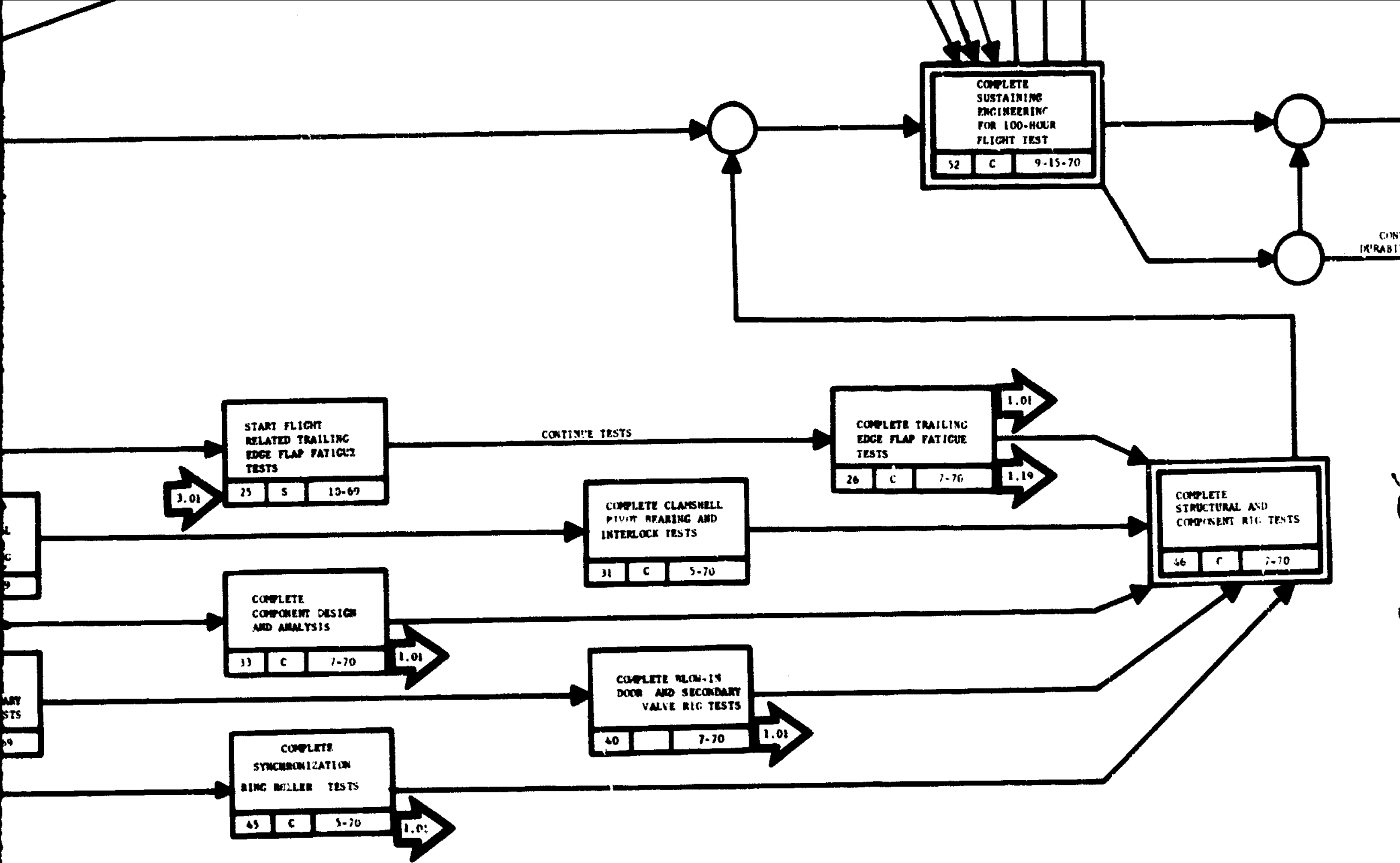
EVENT DICTIONARY
1.15 EXHAUST SYSTEM

Description and Criteria	Event Number
START TRAILING EDGE FLAP SEAL WEAR AND FATIGUE TESTS Start of trailing edge flap seal wear and fatigue tests. Completion of tests on first configuration.	32
COMPLETE TRAILING EDGE FLAP SEAL WEAR AND FATIGUE TESTS Completion of trailing edge flap seal wear and fatigue tests. Completion of last seal test.	33
START TRAILING EDGE FLAP ASSEMBLY FATIGUE TESTS Start of testing of trailing edge flap. Completion of first test.	34
START FLIGHT RELATED TRAILING EDGE FLAP FATIGUE TESTS Start of testing of trailing edge flap using flight test data input. Completion of first test.	35
COMPLETE TRAILING EDGE FLAP FATIGUE TESTS Completion of all trailing edge flap fatigue testing. Completion of last test.	36
START CLAMSHELL RIG DESIGN AND FABRICATION Start of clamshell rig design and fabrication. Completion of first design drawings.	37
START PIVOT BEARING AND INTERLOCK RIG TESTING Start of pivot bearing and clamshell interlock testing. Completion of first test.	38
COMPLETE PIVOT BEARING AND INTERLOCK RIG TESTING Completion of pivot bearing and clamshell interlock rig testing. Completion of last test.	39
START FLIGHT RELATED CLAMSHELL PIVOT BEARING AND INTERLOCK TESTING Start testing of clamshell bearing and interlock using flight test data input. Completion of first test.	40
COMPLETE CLAMSHELL PIVOT BEARING AND INTERLOCK TESTS Completion of all clamshell pivot bearing and interlock tests. Completion of last test.	41

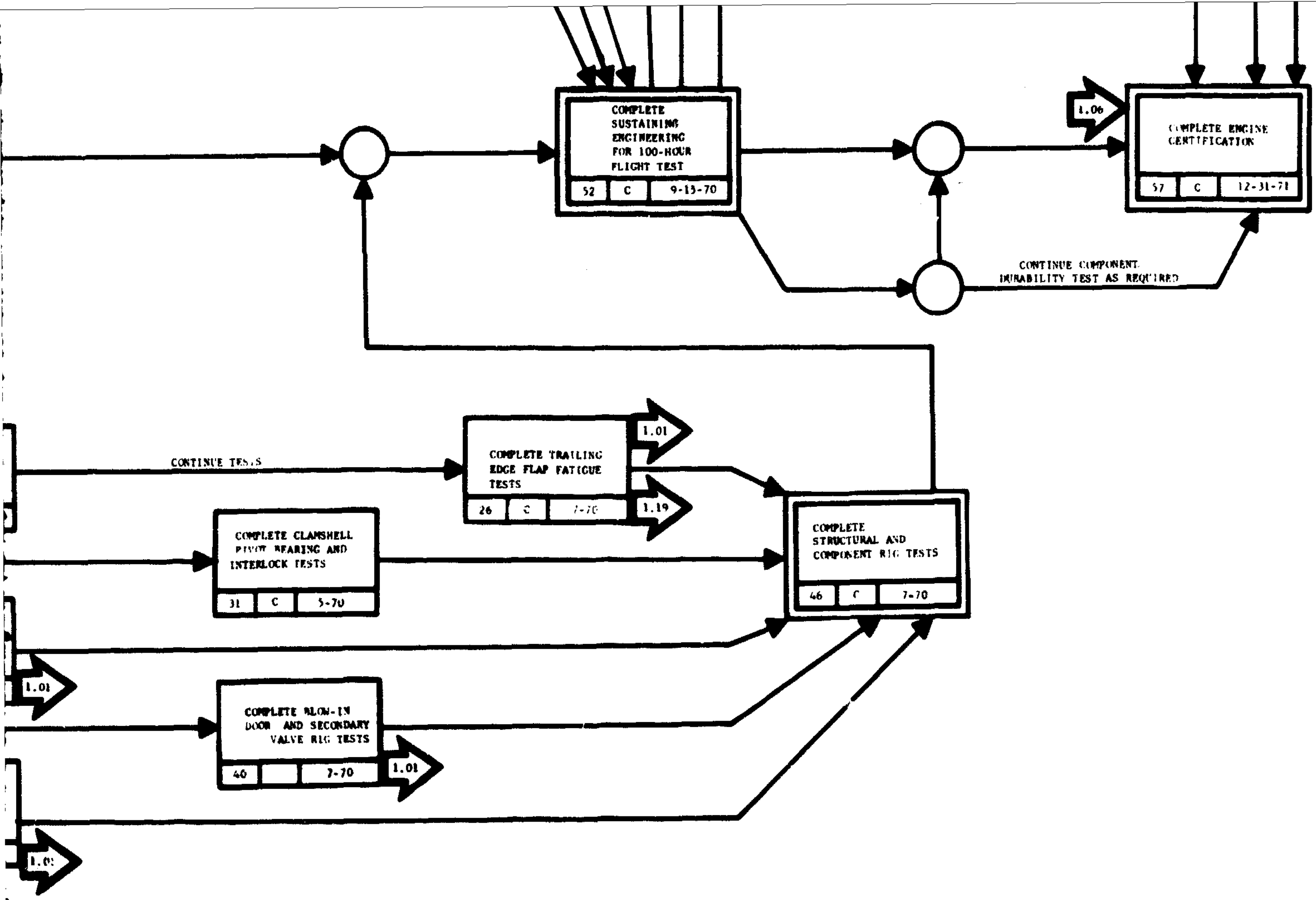
Description and Criteria	Event Number
CONTINUE COMPONENT DESIGN AND ANALYSIS Continuation of exhaust system component design and analysis. Initiation of Phase III component design.	42
COMPLETE COMPONENT DESIGN AND ANALYSIS Completion of exhaust system component design and analysis. Completion of last component design.	43
START BLOW-IN-DOOR AND SECONDARY AIR VALVE RIG DESIGN Start of design of blow-in-door and secondary air valve rig design. Completion of first design drawing.	44
START BLOW-IN-DOOR RIG TESTS Start of tests on blow-in-door rig. Completion of first test.	45
COMPLETE BLOW-IN-DOOR RIG TESTS Completion of tests on blow-in-door rig. Completion of last test.	46
START SECONDARY AIR VALVE RIG TESTS Start of tests on secondary air valve rig. Completion of first test.	47
COMPLETE SECONDARY AIR VALVE RIG TESTS Completion of tests on secondary air valve rig. Completion of last test.	48
START FLIGHT RELATED BLOW-IN-DOOR AND SECONDARY AIR VALVE RIG TESTS Start of testing on blow-in-door and secondary air valve rig. Completion of first test.	49
COMPLETE BLOW-IN-DOOR AND SECONDARY VALVE RIG TESTS Completion of blow-in-door and secondary valve rig tests. Completion of last test.	50
START SYNCHRONIZATION RING ROLLER AND SEAL RIG DESIGN Start of design of synchronization ring roller and seal rig. Completion of first design drawing.	51
	52

Description and Criteria
START SYNCHRONIZATION RING ROLLER T[illegible] Start of exhaust nozzle synchronization [illegible] roller tests. Completion of first test
START SYNCHRONIZATION RING SEAL TEST Start of testing of exhaust nozzle syn[illegible] [illegible] ring seals. Completion of first [illegible]
COMPLETE SYNCHRONIZATION RING SEAL TEST Completion of nozzle synchronization ring se[illegible] Completion of last test.
COMPLETE SYNCHRONIZATION RING ROLLER T[illegible] Completion of exhaust nozzle synchroniza[illegible] ring roller tests. Completion of last [illegible]
COMPLETE STRUCTURAL AND COMPONENT RIG [illegible] Completion of structural testing of exh[illegible] system components on rigs. Completion [illegible] on last component configuration.
START ENGINE TEST AT AEDC Initiation of engine testing at AEDC [illegible] [illegible] Engine test is in p[illegible]
COMPLETE DESIGN OF DEVELOPMENT CONFIGURA[illegible] Completion of design of fullscale exha[illegible] for early prototype engines. Manufactu[illegible] are released.
COMPLETE COORDINATED INSTALLATION Complete design of exhaust nozzle [illegible] [illegible] integrated with airframe [illegible] Manufacturing drawings are released.
START ENGINE TESTS DEVELOPMENT CONFIGURA[illegible] Start engine testing of initial prototype system. Initial engine test is in pro[illegible]
SELECT PTS CONFIGURATION Select a test/early-approved configurati[illegible] for engine PTS testing. Incorporate [illegible] configuration into PTS engine design.
COMPLETE ENGINEERING ENGINEERING FOR [illegible] FLIGHT TEST Completion of 100 hours of flight test [illegible]

18



Description and Criteria	Event Number	Description and Criteria
...ART SYNCHRONIZATION RING ROLLER TESTS [illegible]	[illegible]	SELECT CERTIFICATION CONFIGURATION [illegible] certification engine design.
...ART SYNCHRONIZATION RING SEAL TEST [illegible]	[illegible]	COMPLETE INSTALLATION EFFECTS TESTS [illegible]
...MPLETE SYNCHRONIZATION RING SEAL TESTS [illegible]	[illegible]	COMPLETE MODEL DESIGN AND ANALYSIS [illegible]
...MPLETE SYNCHRONIZATION RING ROLLER TESTS [illegible]	[illegible]	COMPLETE PARTS PROCUREMENT [illegible]
...MPLETE STRUCTURAL AND COMPONENT RIG TESTS [illegible]	[illegible]	ENGINE CERTIFICATION Reference engine network [illegible] for description and criteria.
START ENGINE TEST AT AEDC [illegible]		
COMPLETE DESIGN OF DEVELOPMENT CONFIGURATION [illegible]		
COMPLETE COORDINATED INSTALLATION [illegible]		
START ENGINE TESTS DEVELOPMENT CONFIGURATION [illegible]		
SELECT PTS CONFIGURATION [illegible]		
COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST [illegible] Completion of 100-hours of flight test.		



Event Number	Description and Criteria
	SELECT CERTIFICATION CONFIGURATION Select exhaust system configuration that will be suitable for engine certification testing. Incorporation of selected configuration into certification engine design.
[illegible]	**COMPLETE INSTALLATION EFFECTS TESTS** Completion of model test of installation effects. Completion of last tests.
[illegible]	**COMPLETE MODEL DESIGN AND ANALYSIS** Completion of design and analysis for model tests. Completion of last model design modifications.
[illegible]	**COMPLETE PARTS PROCUREMENT** Completion of procurement [illegible] parts [illegible]. Procurement of last part.
[illegible]	**ENGINE CERTIFICATION** Reference engine network 1.06 for description and criteria.

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1 16 CONTROLS AND ACCESSORIES

FUEL CONTROLS AND ACCESSORIES

During Phase III of the JTF17 engine program, the prototype engine control system design will be completed, fabricated, bench tested, engine tested and flight tested. The prototype control design and development program will rely heavily on experience gained during the J58 engine development program and on present commercial engine experience.

While prototype control components are being procured, development engines will be operated with the modified J58 and TF30 controls used in Phase II-C. Additional controls of this type will be procured to support the development engine program. Information from operation of the development engines, development component rigs, and analytical and computer studies will be used in the refinement of the design of the prototype control system.

Bench testing of prototype control components will include both room temperature testing and environmental testing at simulated mission cycle conditions including fuel inlet temperature and ambient temperature. The objective of this testing is to subject the control components including the fuel controls, the fuel pumps, the ignition system and auxiliary valving to as nearly flight environmental conditions as possible prior to engine and flight test

The engine test program of the prototype control system will be directed toward evaluation of control performance at sea level test stand conditions and under the simulated flight conditions which can be simulated by the test facilities at FRDC. This testing will also accumulate engine endurance time on the control components. The engine test program includes the completion during Phase III of the engine FTS with the prototype control system. Prototype control components will be procured and updated as required to support the engine development program.

The initial 100 hours of aircraft flight testing will evaluate the control system over the flight envelope. Flight testing will also demonstrate engine/inlet/exhaust system compatibility and indicate any problems not resolved by the engine/inlet/exhaust test stand programs. Development programs will be initiated to resolve control system problems encountered in bench testing, engine testing, and initial flight testing.

Analytical design and development coordination will be maintained with the airframe manufacturer to ensure that compatible system performance is achieved; that installation requirements are satisfied; and that engine/inlet/exhaust system tests and initial flight testing are coordinated. Analytical studies and computer programs will be continued to verify the validity of the control system requirements and parameters, as required, to coordinate engine performance with control and inlet system scheduling and dynamics, and to resolve specific control system problems. Major emphasis will continue to be placed on system simplification.

VALVES, ACTUATORS, LINES AND FITTINGS

In support of JTF17 engine testing, actuators, compressor bleed valves, lines and fittings development tests will be conducted during Phase III.

The compressor air bleed valves are very similar to the poppet valves utilized in the commercial JT8D and military JT8 engines. These valves are located on the gas generator and are required to provide reliable, trouble-free operation after long periods of exposure to high temperature. Extensive testing which will include calibration, cycle and exposure under hot and cold environment, contamination, and flow capacity tests will be accomplished.

Linear actuators that operate the high compressor variable inlet guide vanes (IGV), the variable area duct nozzle, and the reverser-suppressor clamshells are required to perform through a wide range of working fluid pressures and temperatures and ambient temperatures; to maintain stable operation for varying load conditions; and to operate with negligible overboard leakage. The major areas of actuator development will be directed toward substantiation testing of substitution of titanium alloy for Greek Ascoloy material (AMS 5616), which should provide substantial weight savings, and development of the required dynamic seal durability. Extensive testing which will include hot and cold environment, calibration, heat transfer, endurance, and contamination will be accomplished.

An alternate mechanical actuation system will be studied to evaluate the feasibility of simplifying the actuation system and to assess the advantages and disadvantages of mechanical system development in relation to the JTF17 hydraulic actuation system.

The engine lines and fittings must safely carry the working fluids to several locations on the engine through a wide range of operational pressures and temperatures. To accomplish this task, these working fluid lines employ tubing that ranges in diameter from 5/16 to 2-1/2 inches with wall thickness that ranges from 0.035 to 0.065 inch. Mechanical tube connectors are utilized to provide quick installation, servicing and removal of the components, and to provide ease of engine disassembly and overhaul.

Major effort will be expended on lines and fittings to develop titanium tubing and mechanical connectors which are compatible with titanium tubing, and related seals. This effort will consist of upset forming, welding, bending tests, vibratory tests, salt water tests, fuel and oil compatibility tests, heat transfer tests, and mechanical connector and seal tests.

The major milestones, network charts and event dictionaries for controls, valves, actuators, lines, fittings and accessories are shown in figures 31 and 32, respectively.

A detailed description of controls, valves, actuators, lines, fittings, and accessories development is presented in the Test and Certification Plan, Volume III, Report E, and test planning and integration is presented in Test, Volume IV, Report E.

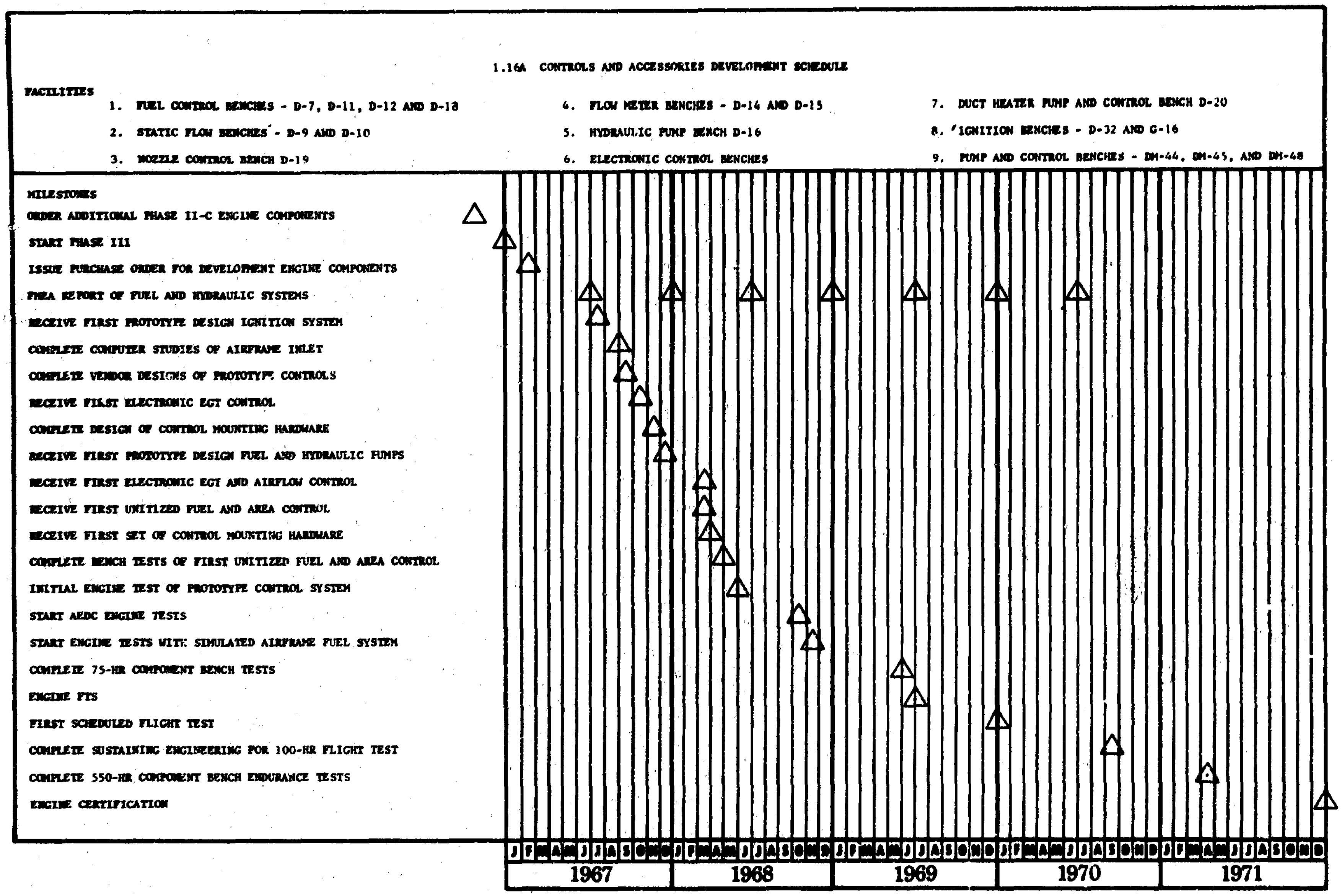

Figure 31. 1.16 Controls and Accessories (Sheet 1 of 2)

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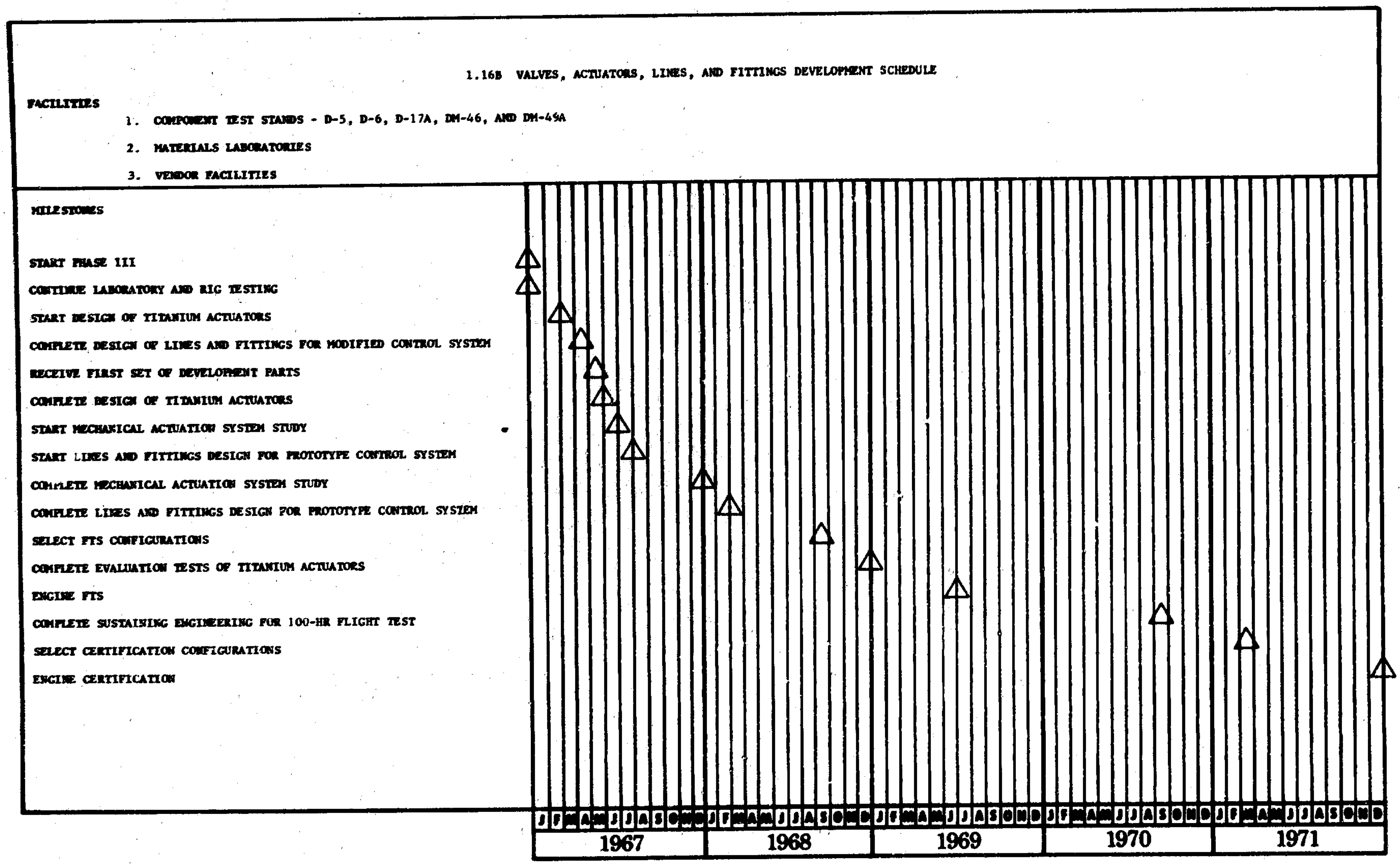

Figure 31. 1.16 Controls and Accessories
(Sheet 2 of 2)

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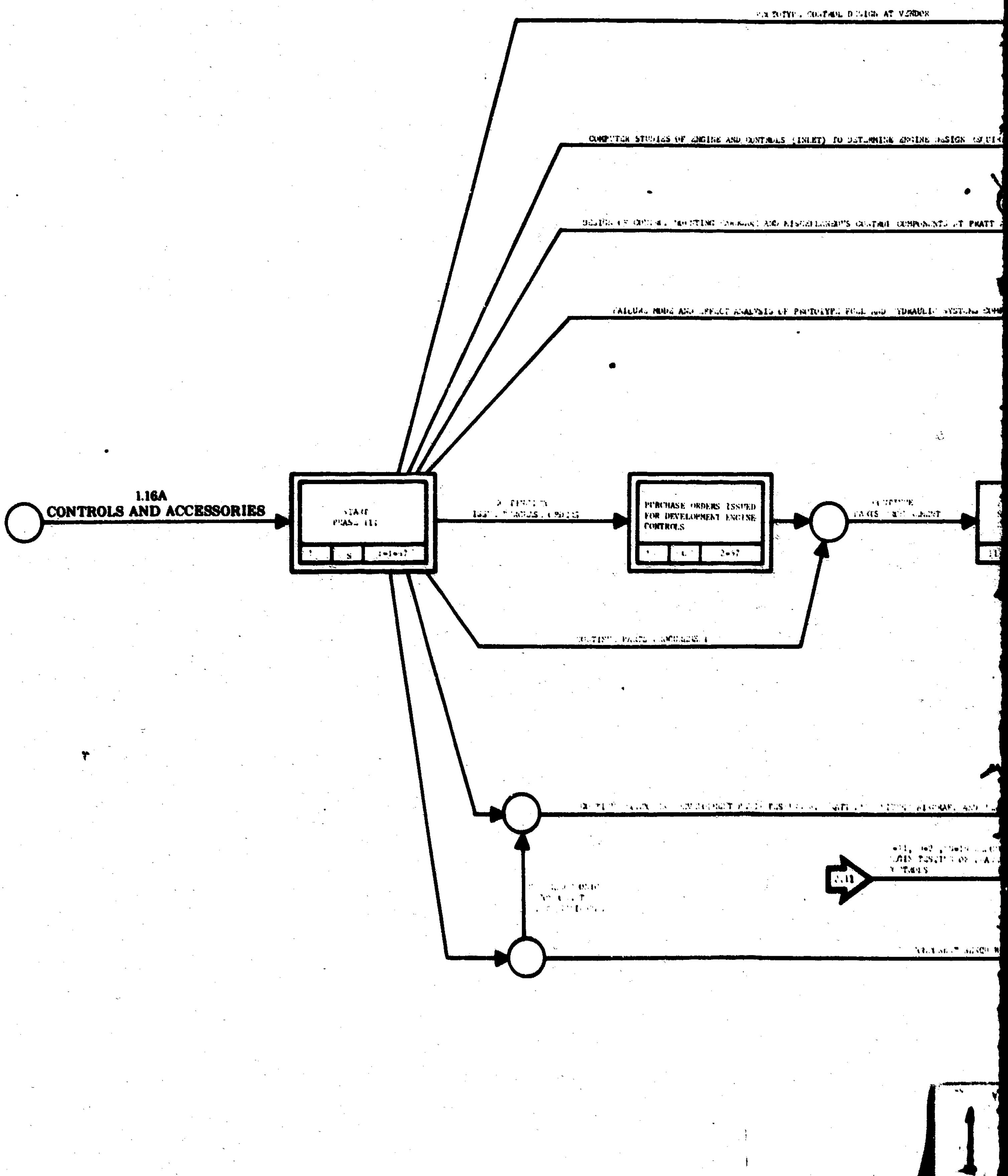
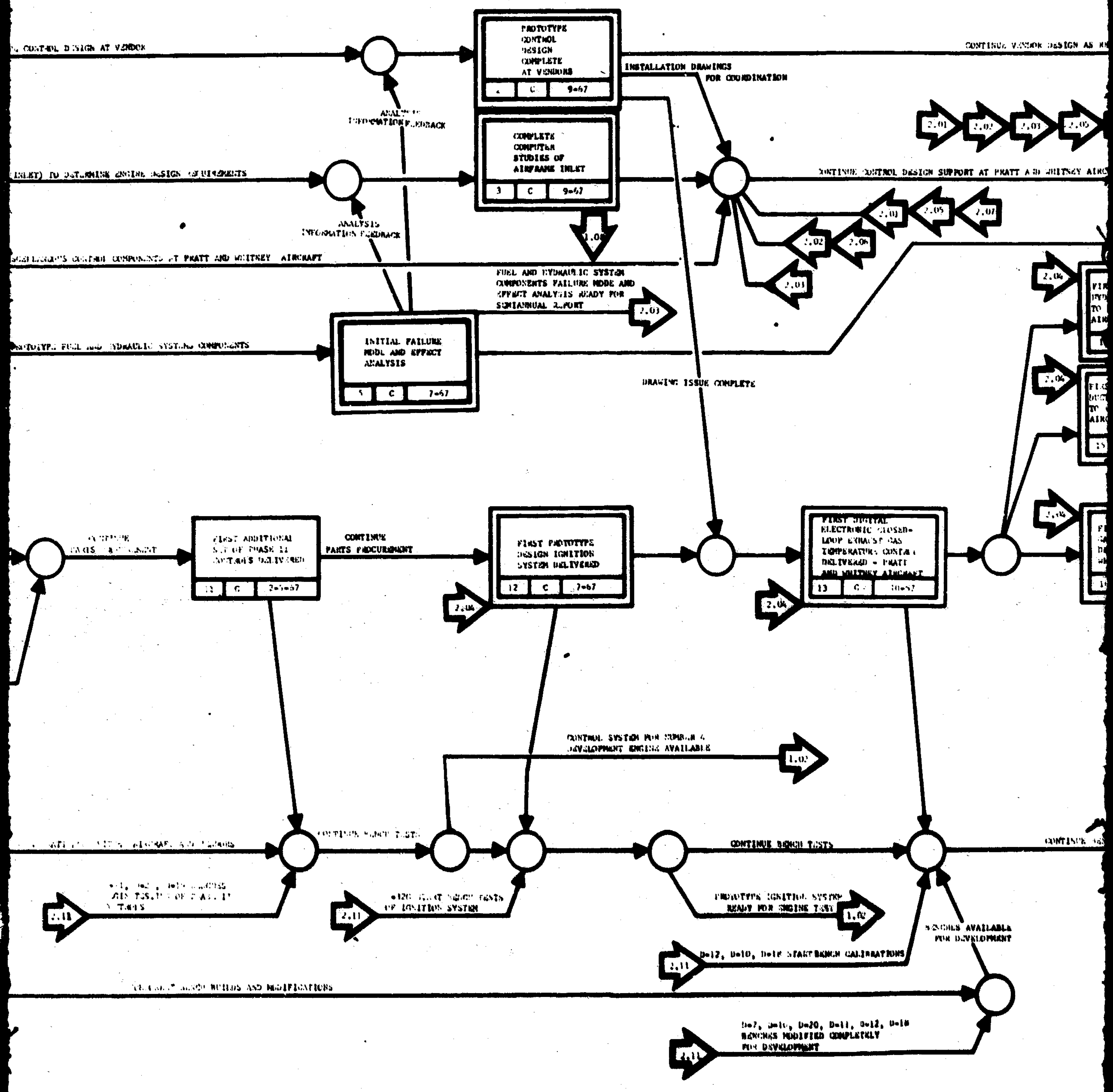
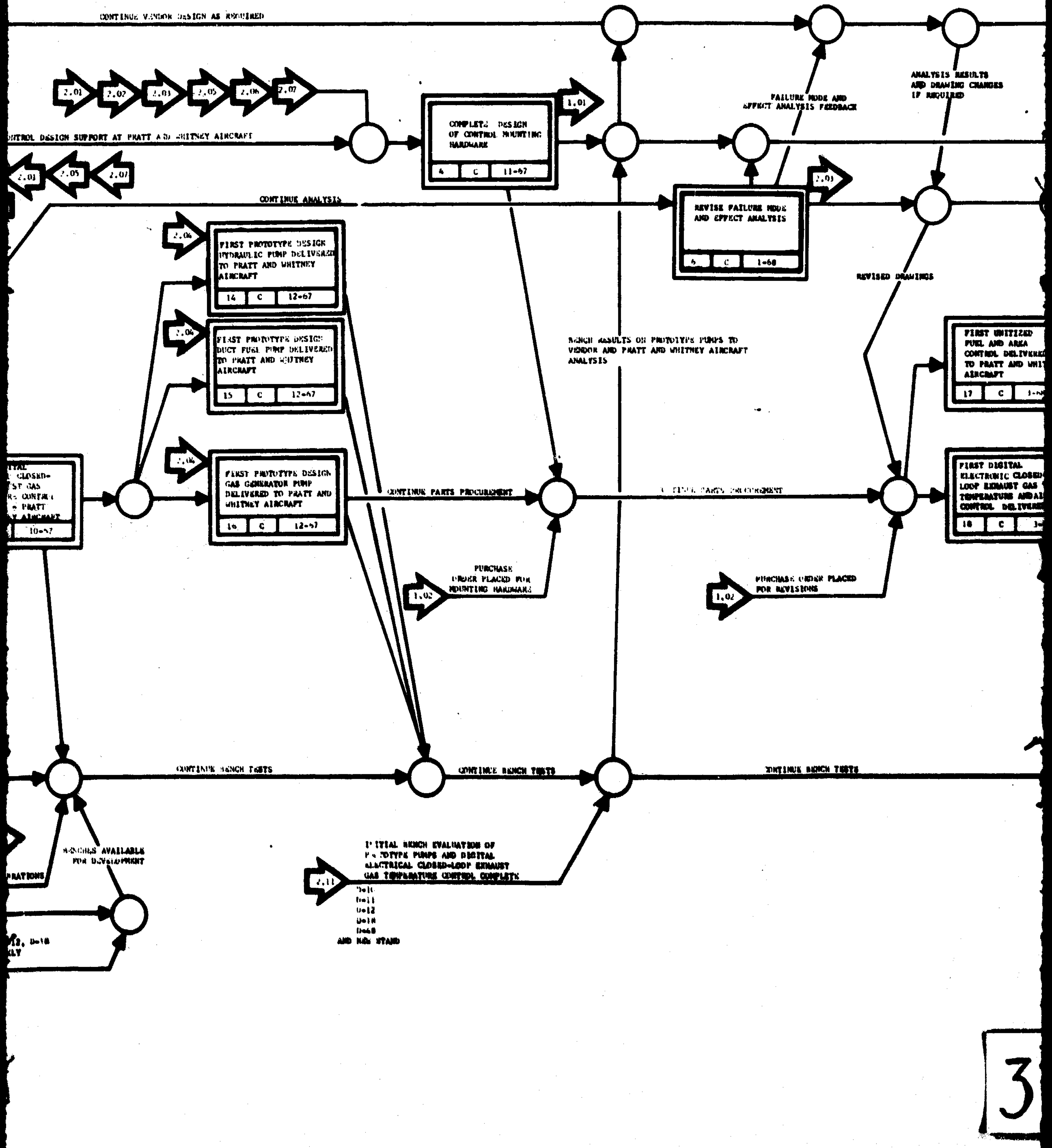
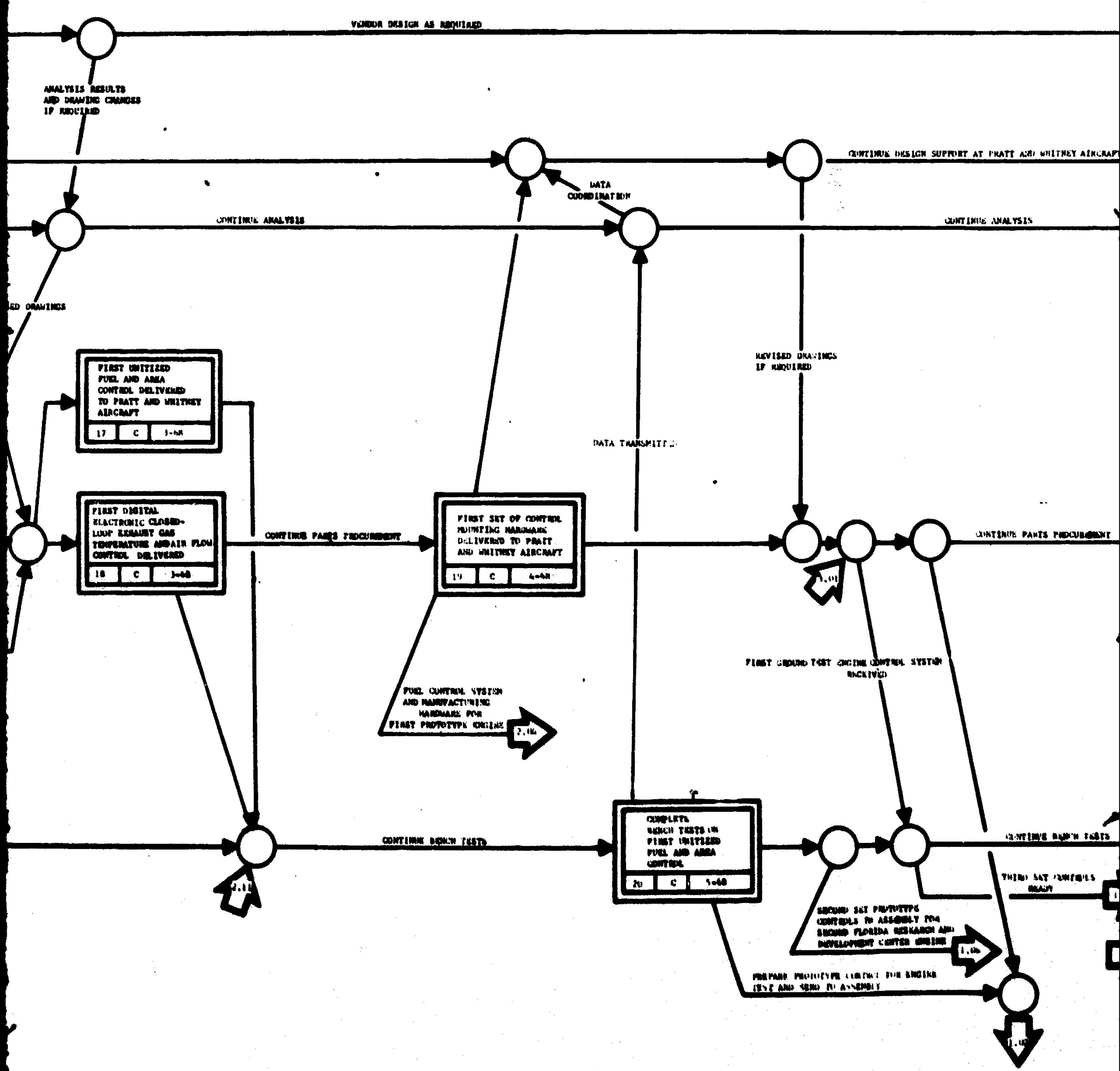

1.16A
CONTROLS AND ACCESSORIES
PURCHASE ORDERS ISSUED FOR DEVELOPMENT ENGINE CONTROLS



PROTOTYPE CONTROL DESIGN COMPLETE AT VENDORS
9-67
INSTALLATION DRAWINGS FOR COORDINATION
COMPLETE COMPUTER STUDIES OF AIRFRAME INLET
3 C 9-67
ANALYSIS INFORMATION FEEDBACK
FUEL AND HYDRAULIC SYSTEM COMPONENTS FAILURE MODE AND EFFECT ANALYSIS READY FOR SEMIANNUAL REPORT
INITIAL FAILURE MODE AND EFFECT ANALYSIS
5 C 7-67
DRAWING ISSUE COMPLETE
CONTINUE PARTS PROCUREMENT
FIRST PROTOTYPE DESIGN IGNITION SYSTEM DELIVERED
12 C 7-67
FIRST DIGITAL ELECTRONIC CLOSED-LOOP EXHAUST GAS TEMPERATURE CONTROL DELIVERED - PRATT AND WHITNEY AIRCRAFT
13
CONTROL SYSTEM FOR NUMBER 4 DEVELOPMENT ENGINE AVAILABLE
CONTINUE BENCH TESTS
PROTOTYPE IGNITION SYSTEM READY FOR ENGINE TEST
BENCHES AVAILABLE FOR DEVELOPMENT
BENCH BUILDS AND MODIFICATIONS
BENCHES MODIFIED COMPLETELY FOR DEVELOPMENT



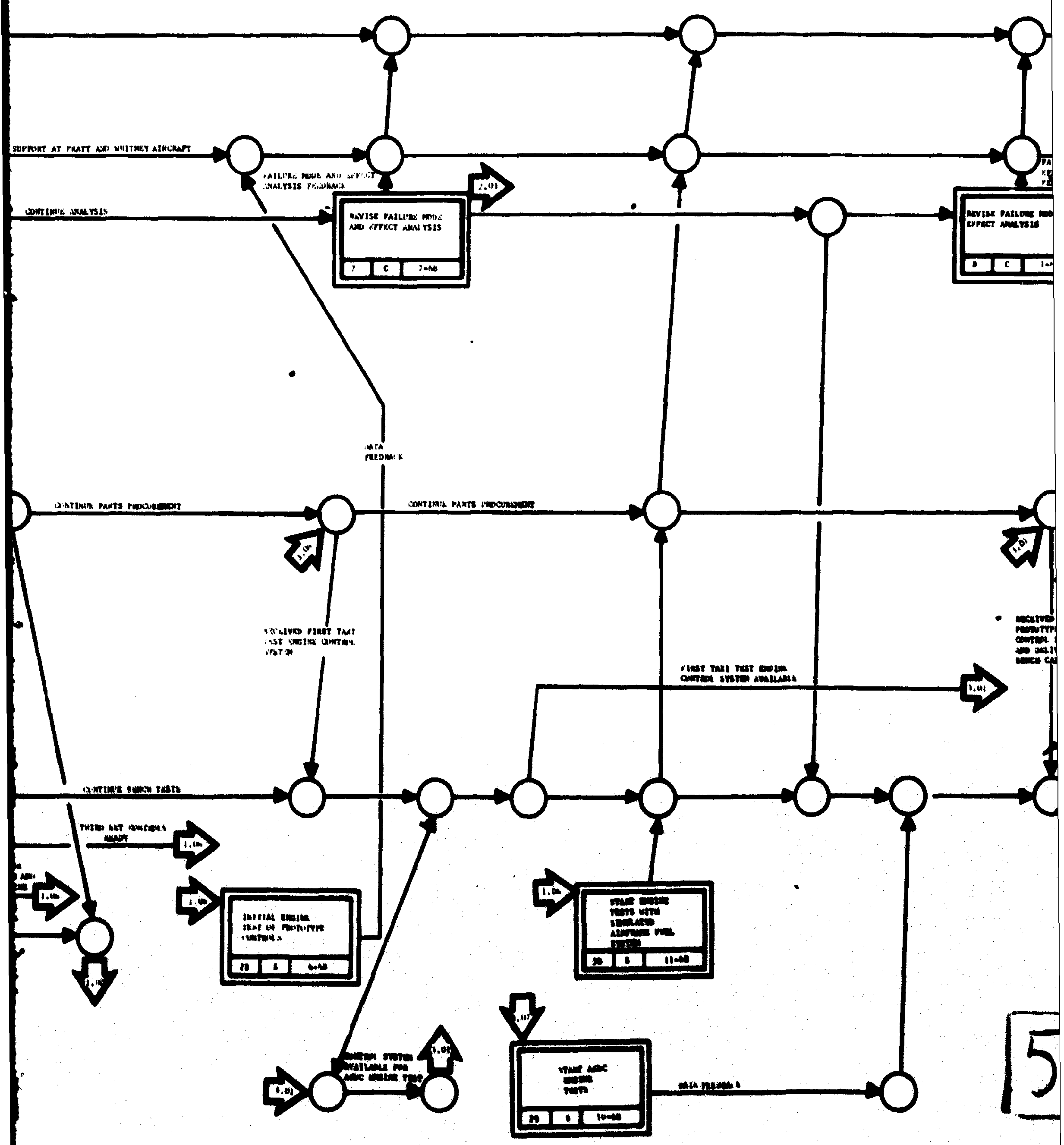
CONTINUE VENDOR DESIGN AS REQUIRED
2.01
2.02
2.03
2.05
2.06
2.07
CONTROL DESIGN SUPPORT AT PRATT AND WHITNEY AIRCRAFT
COMPLETE DESIGN OF CONTROL MOUNTING HARDWARE
4
C
11-67
1.01
FAILURE MODE AND EFFECT ANALYSIS FEEDBACK
ANALYSIS RESULTS AND DRAWING CHANGES IF REQUIRED
CONTINUE ANALYSIS
REVISE FAILURE MODE AND EFFECT ANALYSIS
6
C
1-68
2.03
REVISED DRAWINGS
2.04
FIRST PROTOTYPE DESIGN HYDRAULIC PUMP DELIVERED TO PRATT AND WHITNEY AIRCRAFT
14
C
12-67
FIRST PROTOTYPE DESIGN DUCT FUEL PUMP DELIVERED TO PRATT AND WHITNEY AIRCRAFT
15
C
12-67
BENCH RESULTS ON PROTOTYPE PUMPS TO VENDOR AND PRATT AND WHITNEY AIRCRAFT ANALYSIS
FIRST UNITIZED FUEL AND AREA CONTROL DELIVERED TO PRATT AND WHITNEY AIRCRAFT
17
C
FIRST PROTOTYPE DESIGN GAS GENERATOR PUMP DELIVERED TO PRATT AND WHITNEY AIRCRAFT
16
C
12-67
CONTINUE PARTS PROCUREMENT
FIRST DIGITAL ELECTRONIC CLOSED-LOOP EXHAUST GAS TEMPERATURE AND AIR CONTROL DELIVERED
18
C
10-67
PURCHASE ORDER PLACED FOR MOUNTING HARDWARE
1.02
PURCHASE ORDER PLACED FOR REVISIONS
1.02
CONTINUE BENCH TESTS
CONTINUE BENCH TESTS
CONTINUE BENCH TESTS
BENCHES AVAILABLE FOR DEVELOPMENT
INITIAL BENCH EVALUATION OF PROTOTYPE PUMPS AND DIGITAL ELECTRICAL CLOSED-LOOP EXHAUST GAS TEMPERATURE CONTROL COMPLETE
2.11
D-10
D-11
D-12
D-18
D-48
AND N&E STAND
3



4

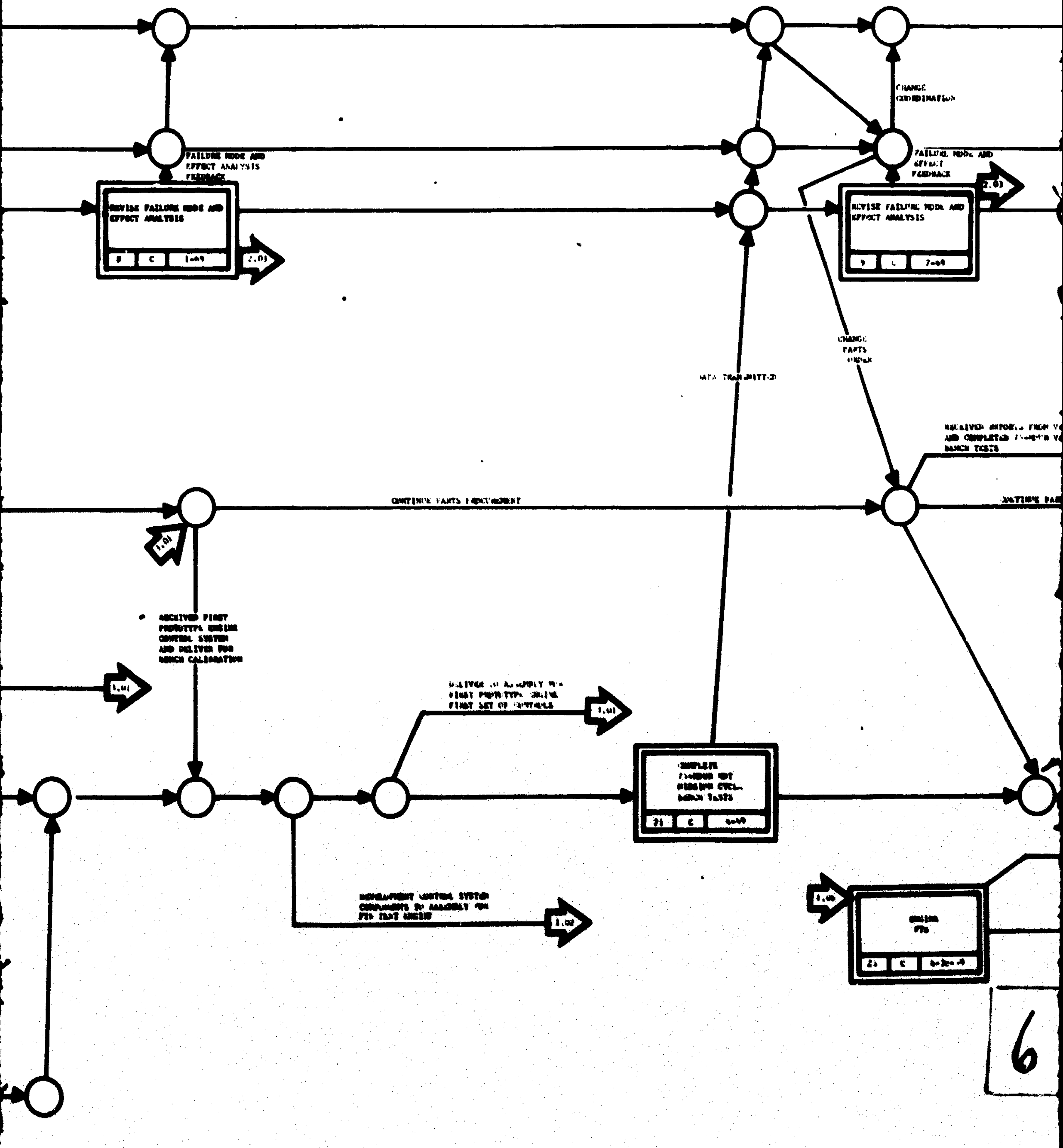
Event Number	Description and Criteria	Event Number
1	START PHASE III Start of Phase III. Phase III [illegible] from FAA	[illegible]
2	PROTOTYPE CONTROL DESIGN COMPLETE AT VENDOR The vendor's prototype control design is complete. Drawings released to vendor manufacturing.	11
3	COMPLETE COMPUTER STUDIES OF AIRFRAME INLET The program will determine the control system dynamic requirements which will result in safe engine operation and will ensure that the compatibility necessary with the airframe air inlet system is obtained. Successful completion of	12

1.16A Fuel Controls and Accessories

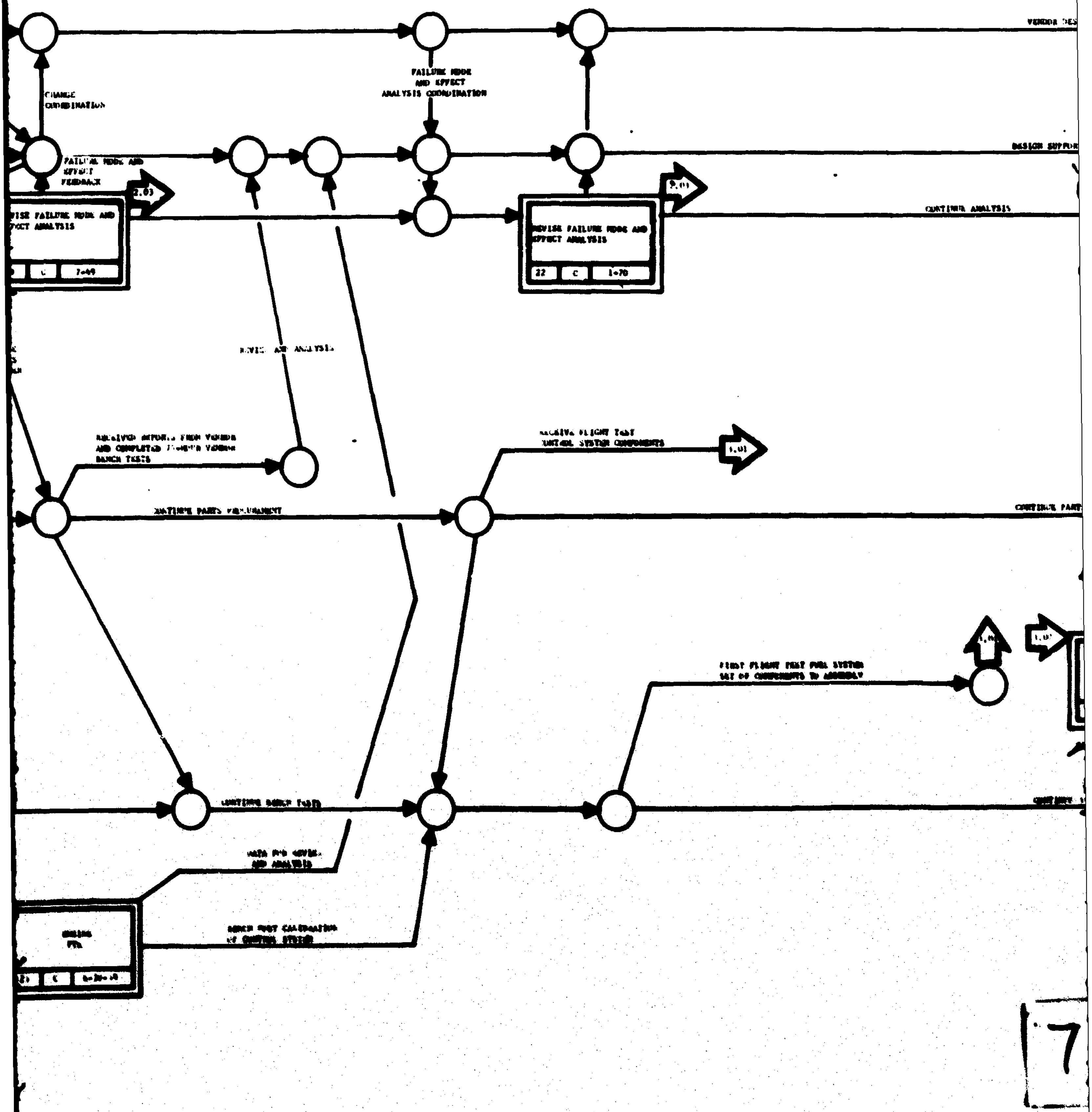


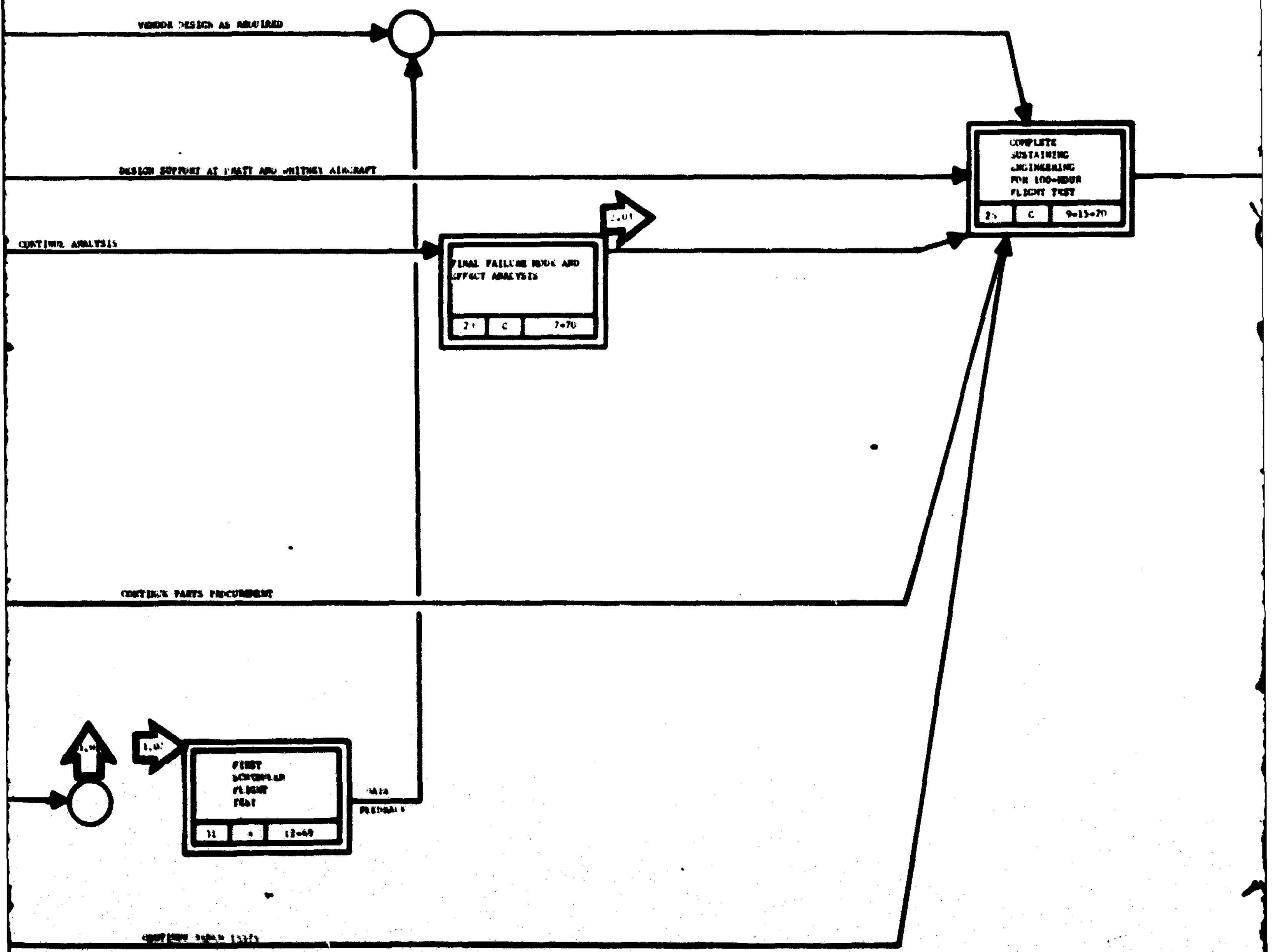
EVENT DICTIONARY
1.16A CONTROLS AND ACCESSORIES

Event Number	Description and Criteria	Event Number	Description and Criteria	Event Number
10	**PURCHASE ORDERS ISSUED FOR DEVELOPMENT ENGINE CONTROLS** [illegible]	16	**FIRST DIGITAL ELECTRONIC CLOSED LOOP SET AND AIRFLOW CONTROL DELIVERED** [illegible]	
11	**FIRST ADDITIONAL SET OF PHASE II CONTROLS DELIVERED** [illegible]	19	**1ST SET OF CONTROL MOUNTING HARDWARE DELIVERED TO PRATT AND WHITNEY AIRCRAFT** [illegible]	20
12	**FIRST PROTOTYPE DESIGN IGNITION SYSTEM DELIVERED**			24



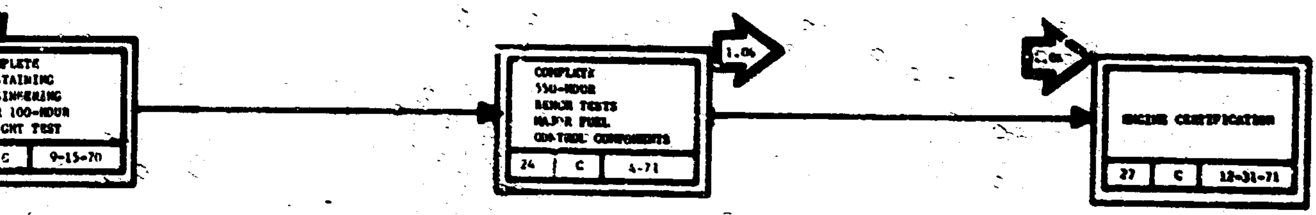
Event Number	Description and Criteria
[illegible]	**ENGINE CERTIFICATION** Reference engine network [illegible] for description and criteria.
[illegible]	**INITIAL ENGINE TEST OF PROTOTYPE CONTROLS** Initial Engine Test of Prototype Controls as described in engine network [illegible]. Test in progress.
[illegible]	**START ADDC ENGINE TESTS** Start ADDC engine tests as described in engine network 3.07. Tests in progress.


FAILURE MODE
AND EFFECT
ANALYSIS COORDINATION
CHANGE
COORDINATION
REVISE FAILURE MODE AND
EFFECT ANALYSIS
22
C
1+70
CONTINUE ANALYSIS
RECEIVE FLIGHT TEST
CONTROL SYSTEM COMPONENTS
CONTINUE PARTS PROCUREMENT
CONTINUE BENCH TESTS
FIRST FLIGHT TEST FUEL SYSTEM
SET OF COMPONENTS TO ASSEMBLY
DATA FOR REVIEW
AND ANALYSIS
BENCH TEST CALIBRATION
OF CONTROL SYSTEM
7


VENDOR DESIGN AS REQUIRED
DESIGN SUPPORT AT PRATT AND WHITNEY AIRCRAFT
CONTINUE ANALYSIS
FINAL FAILURE MODE AND EFFECT ANALYSIS
C
7-70
COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST
C
9-15-70
CONTINUE PARTS PROCUREMENT
FIRST SCHEDULED FLIGHT TEST
12-69
DATA FEEDBACK

8

Figure 32.



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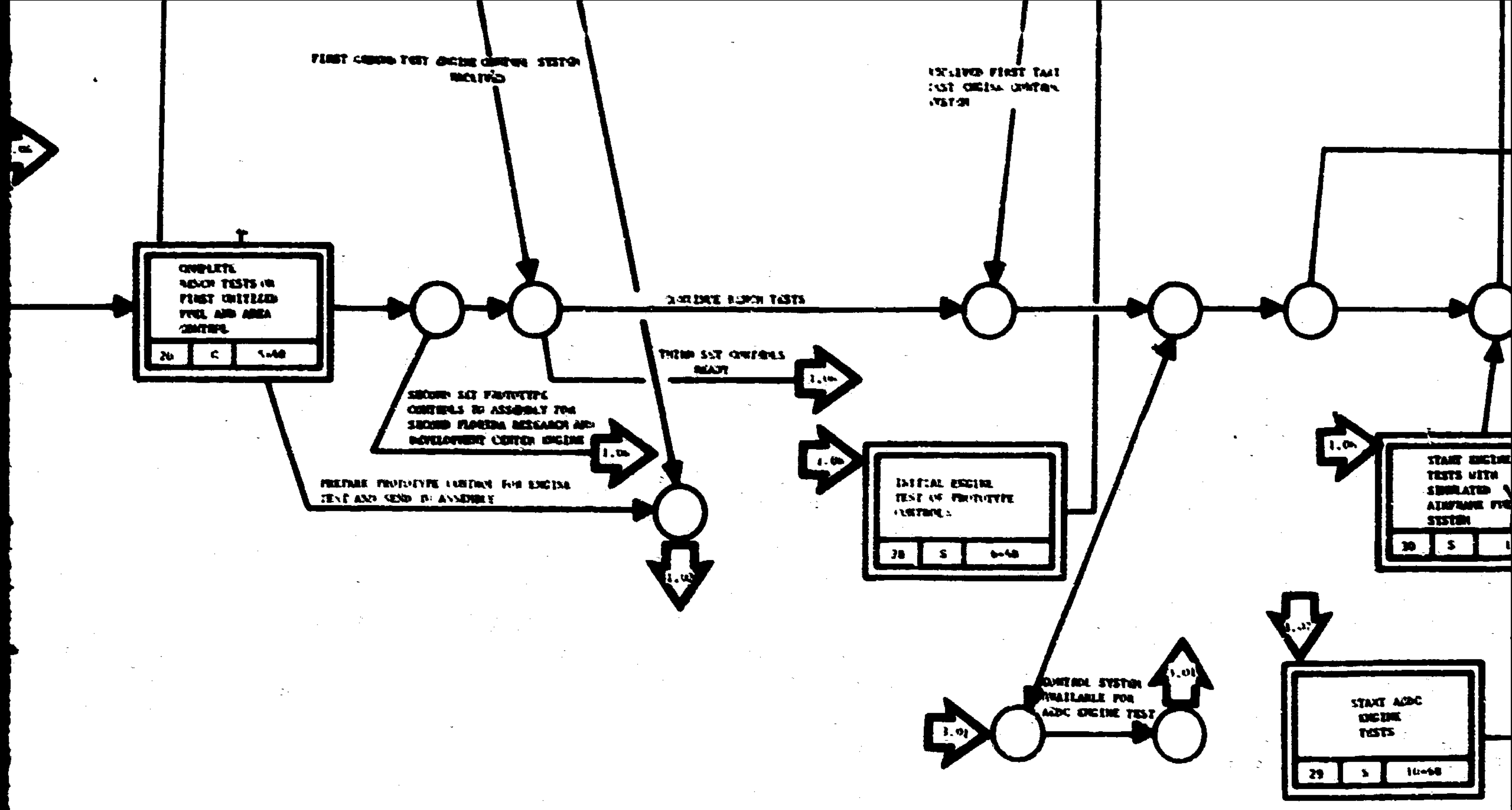

EVENT DICTIONARY
ENGINE CONTROLS AND ACCESSORIES

Event Number	Description and Criteria
1	**START PHASE III** Start of Phase III. Phase III contract received from FAA
2	**PROTOTYPE CONTROL DESIGN COMPLETE AT VENDOR** The vendor's prototype control design is complete. Drawings released to vendor manufacturing.
3	**COMPLETE COMPUTER STUDIES OF AIRFRAME INLET** The program will determine the control system dynamic requirements which will result in safe engine operation and will ensure that the compatibility necessary with the airframe air inlet system is obtained. Successful completion of the program will be shown by demonstrating on a computer simulation that the determined requirements will provide the desired control.
4	**COMPLETE DESIGN OF CONTROL MOUNTING HARDWARE** Control hardware design is complete at FRDC. Drawings released to FRDC manufacturing.
5	**INITIAL FAILURE MODE AND EFFECTS ANALYSIS** Complete an initial FMEA on JTF17 fuel, hydraulic and ignition system components. Publish the FMEA as part of semiannual Reliability reports.
6	**REVISE FAILURE MODE AND EFFECTS ANALYSIS** Revise the existing FMEA on JTF17 fuel, hydraulic and ignition system components. Publish the FMEA as part of semiannual Reliability reports.
7	**REVISE FAILURE MODE AND EFFECTS ANALYSIS** Revise the existing FMEA on JTF17 fuel, hydraulic, and ignition systems components. Publish the FMEA as part of semiannual Reliability reports.
8	**REVISE FAILURE MODE AND EFFECTS ANALYSIS** Revise existing FMEA on JTF17 fuel, hydraulic and ignition systems components. Publish the FMEA as part of semiannual Reliability reports.
9	**REVISE FAILURE MODE AND EFFECTS ANALYSIS** Revise the existing FMEA on JTF17 fuel, hydraulic and ignition systems components. Publish the FMEA as part of semiannual Reliability reports.

Event Number	Description and Criteria
10	**PURCHASE ORDERS ISSUED FOR DEVELOPMENT ENGINE CONTROLS** Purchase orders for vendor components are complete. All vendor purchase orders are placed by P&WA Purchasing Department with vendors.
11	**FIRST ADDITIONAL SET OF PHASE II CONTROLS DELIVERED** 1st engine set of modified initial engine controls delivered to FRDC during Phase III. Receipt at FRDC of a complete set of modified initial engine controls.
12	**FIRST PROTOTYPE DESIGN IGNITION SYSTEM DELIVERED** 1st prototype ignition system delivered to FRDC during Phase III. Receipt at FRDC of a prototype ignition system.
13	**FIRST DIGITAL ELECTRONIC CLOSED LOOP EGT CONTROL DELIVERED TO PRATT AND WHITNEY AIRCRAFT** 1st digital electronic closed loop EGT control delivered to FRDC during Phase III. Receipt at FRDC of a digital electronic closed loop EGT control.
14	**FIRST PROTOTYPE DESIGN HYDRAULIC PUMP DELIVERED TO PRATT AND WHITNEY AIRCRAFT** 1st prototype hydraulic pump delivered to P&WA during Phase III. Receipt at FRDC of a prototype hydraulic pump.
15	**FIRST PROTOTYPE DESIGN DUCT FUEL PUMP DELIVERED TO PRATT AND WHITNEY AIRCRAFT** 1st prototype duct fuel pump delivered to FRDC during Phase III. Receipt of a prototype duct fuel pump at FRDC.
16	**FIRST PROTOTYPE DESIGN GAS GENERATOR PUMP DELIVERED TO PRATT AND WHITNEY AIRCRAFT** 1st prototype gas generator pump delivered to FRDC during Phase III. Receipt of a prototype gas generator pump at FRDC.
17	**1ST UNITIZED FUEL AND AREA CONTROL DELIVERED TO PRATT AND WHITNEY AIRCRAFT** 1st unitized fuel and area control delivered to FRDC during Phase III. Receipt at FRDC of unitized fuel and area control.

Event Number
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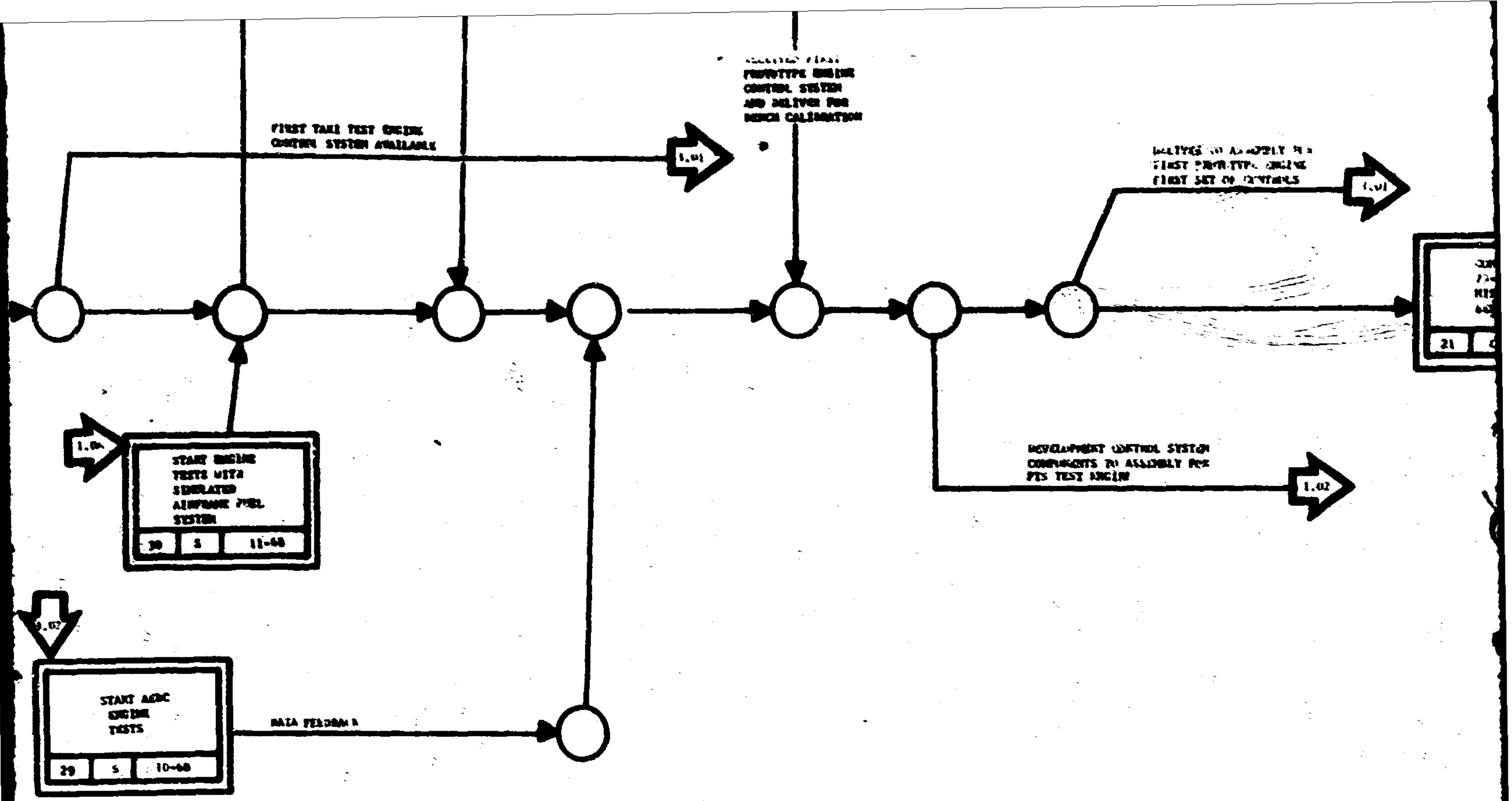
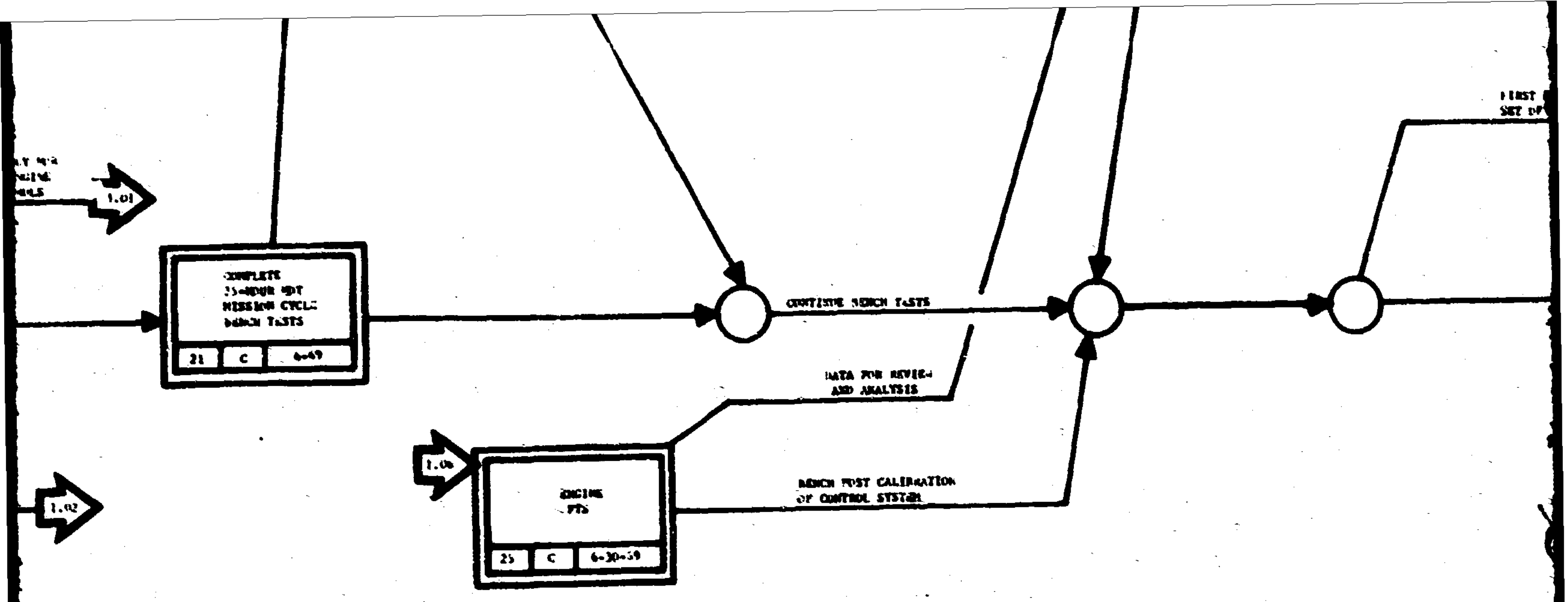
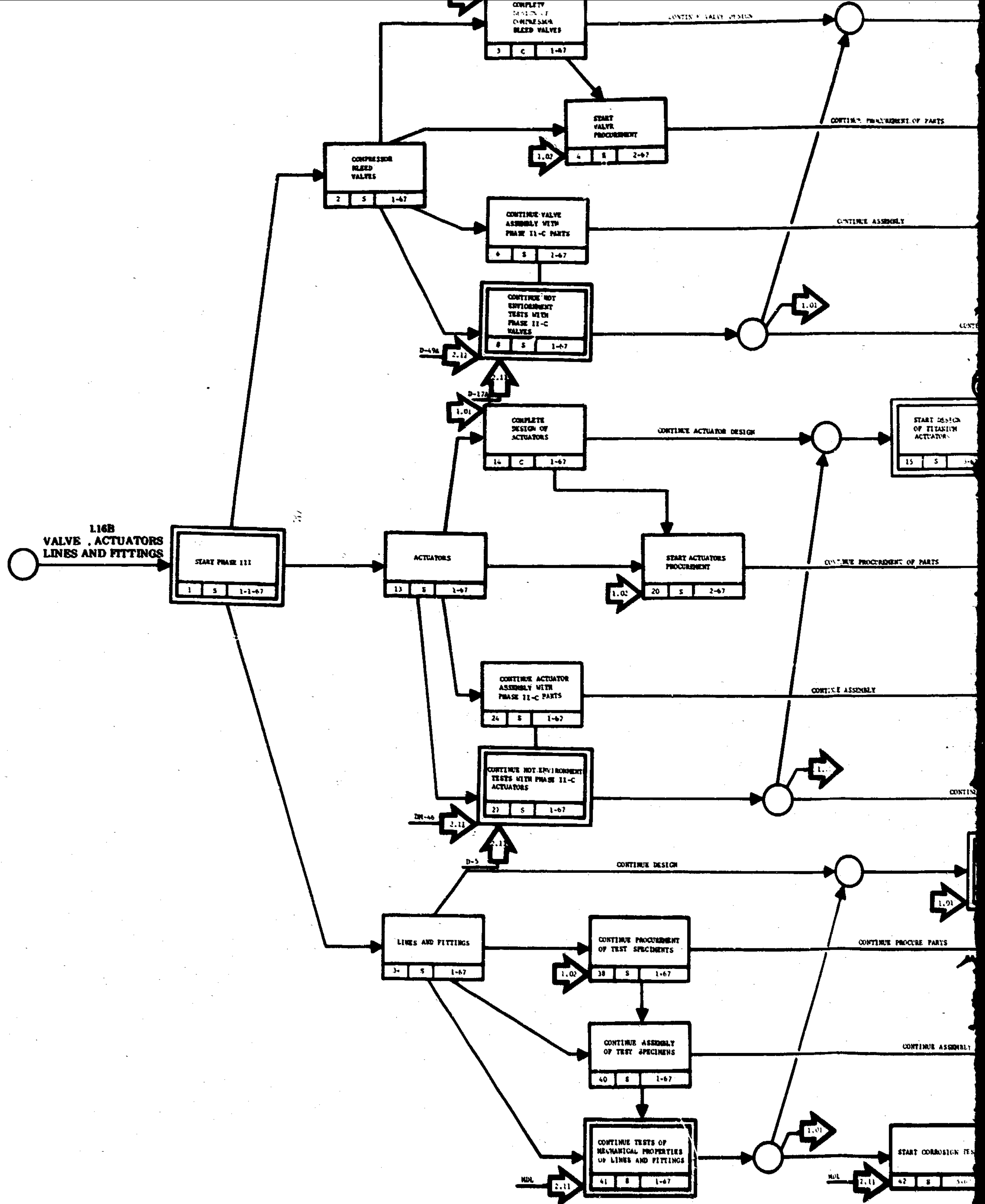


EVENT DICTIONARY
CONTROLS AND ACCESSORIES

Event Number	Description and Criteria
18	**FIRST DIGITAL ELECTRONIC CLOSED LOOP EGT AND AIRFLOW CONTROL DELIVERED** 1st digital electrical closed loop EGT and airflow control delivered to FRDC during Phase III. Receipt at FRDC of a digital electrical closed loop EGT and airflow control.
19	**1ST SET OF CONTROL MOUNTING HARDWARE DELIVERED TO PRATT AND WHITNEY AIRCRAFT** 1st set of control mounting hardware delivered to FRDC during Phase III. Receipt of control mounting hardware at FRDC.
20	**COMPLETE BENCH TESTS ON 1ST UNITIZED FUEL AND AREA CONTROL** Bench tests on 1st unitized fuel and area control are complete. Unitized fuel and area control delivered to component assembly.
21	**COMPLETE 75-HOUR HOT MISSION CYCLE BENCH TESTS** 75-hour hot mission cycle bench test for control system completed. Bench test report published.
22	**REVISE FAILURE MODE AND EFFECTS ANALYSIS** Revise the existing FMEA on JTF17 fuel, hydraulic and ignition system components. Publish the FMEA as part of semiannual Reliability reports.
23	**FINAL FAILURE MODE AND EFFECTS ANALYSIS** Make final revision to the existing FMEA fuel, hydraulic and ignition systems components. Publish the final FMEA as part of semiannual Reliability reports.
24	**COMPLETE 500-HOUR BENCH TESTS MAJOR FUEL CONTROL COMPONENTS** 500-hour bench tests on major fuel control components are complete. Bench-test reports published.
25	**ENGINE FTS** Reference engine network 1.06 for description and criteria.
26	**COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST** Sustaining engineering for 100-hour flight test completed. 100-hour flight test completed.

Event Number	Description and Criteria
27	**ENGINE CERTIFICATION** Reference engine network 1.06 for description and criteria.
28	**INITIAL ENGINE TEST OF PROTOTYPE CONTROLS** Initial Engine Test of Prototype Controls as described in engine network 1.06. Test in progress.
29	**START AEDC ENGINE TESTS** Start AEDC engine tests as described in engine network 3.07. Tests in progress.
30	**START ENGINE TESTS WITH SIMULATED AIRFRAME FUEL SYSTEM** Start engine tests with simulated airframe fuel system as described in engine network 1.06. Tests in progress.
31	**FIRST SCHEDULED FLIGHT TEST** First scheduled flight test as described in engine network 3.07. Test in progress.

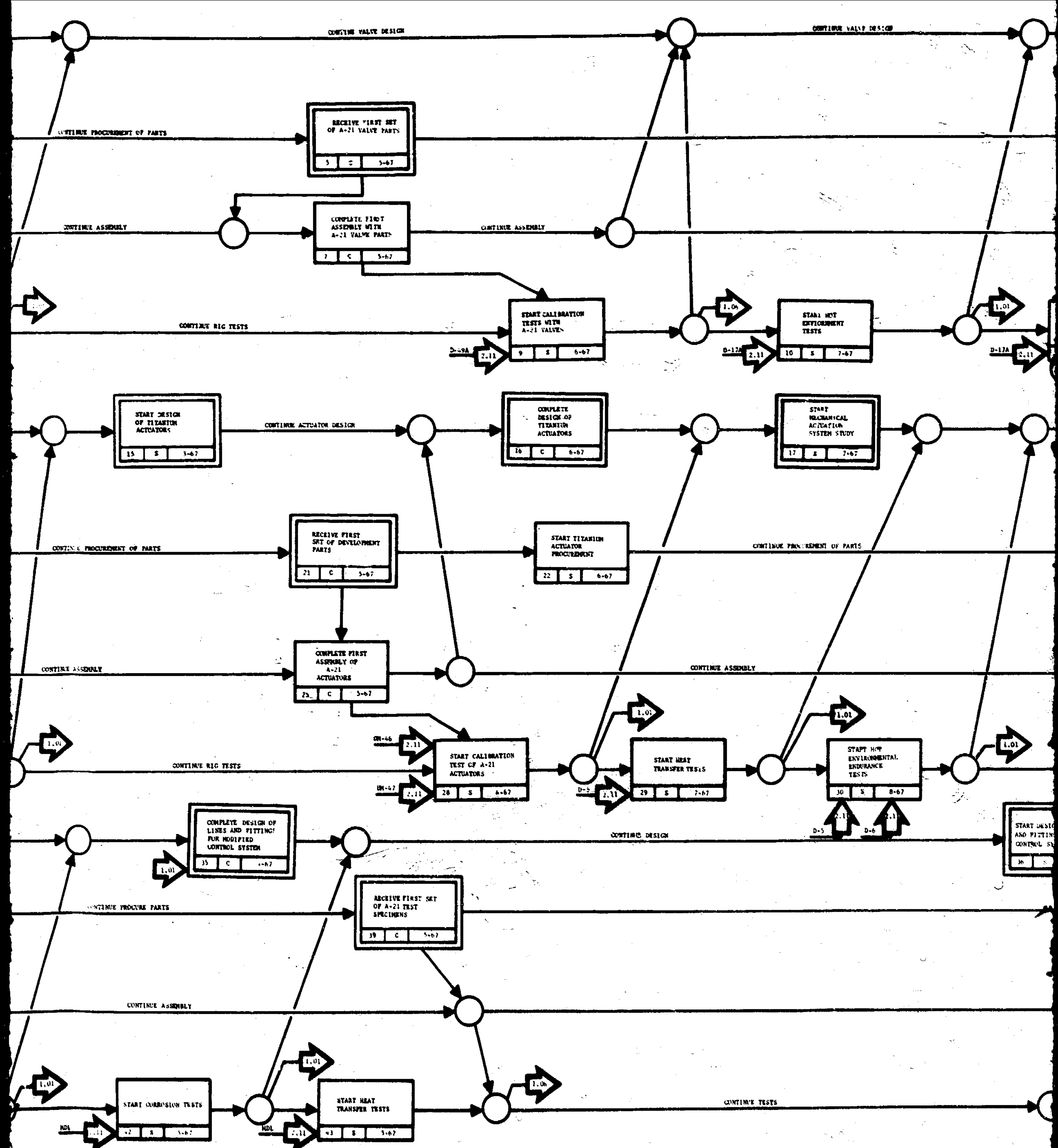

1.01
21
C
1.06
25
C
6-30-59
1.02
DATA FOR REVIEW
AND ANALYSIS



Event Number	Description and Criteria
1	START PHASE III Start of Phase III. Phase III go-ahead received from FAA.
	COMPRESSOR BLEED VALVES [illegible] the design, procurement, assembly, and testing of the compressor bleed valves. Phase III go-ahead received from FAA.
	COMPLETE DESIGN OF COMPRESSOR BLEED VALVES Complete the design [illegible] compressor bleed valves. Drawings are issued.
	START VALVE PROCUREMENT Start [illegible] compressor bleed valve development parts. [illegible] in process.
	RECEIVE FIRST SET OF A-2 VALVE PARTS Procure first set of valves for development tests. Parts are procured and delivered

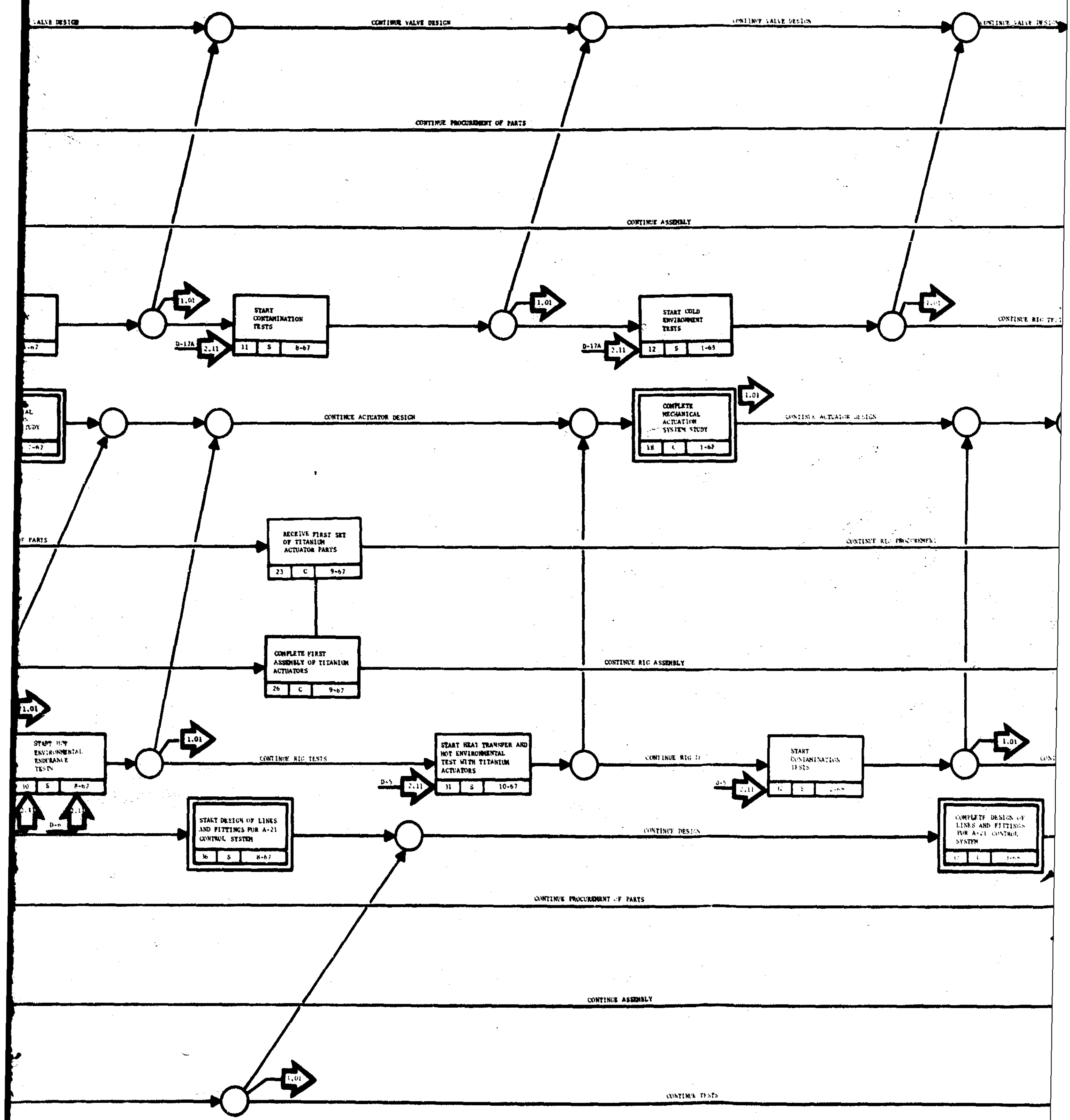
Event Number	Description and Criteria
6	CONTINUE VALVE ASSEMBLY WITH PHASE II-C PARTS [illegible]
	COMPLETE FIRST ASSEMBLY [illegible] VALVE PARTS [illegible]
	CONTINUE NOT ENVIRONMENT [illegible] PHASE II-C VALVES [illegible]
	START CALIBRATION [illegible] VALVES [illegible]
	START [illegible] [illegible]
	START CONTAMINATION [illegible] [illegible] contamination [illegible] tests [illegible] bleed valves. Tests are in process.

Figure 32. 1.16 Controls and Accessories
(Sheet 2 of 2)



Event Number	Description and Criteria	Event Number	Description and Criteria
	START COLD ENVIRONMENT TESTS		START MECHANICAL ACTUATION SYSTEM STUDY
	COMPLETE DESIGN OF ACTUATORS		COMPLETE MECHANICAL ACTUATION SYSTEM STUDY
	START DESIGN OF TITANIUM ACTUATORS		START ACTUATOR PROCUREMENT

2



EVENT DICTIONARY

Event Number | Description of Criteria

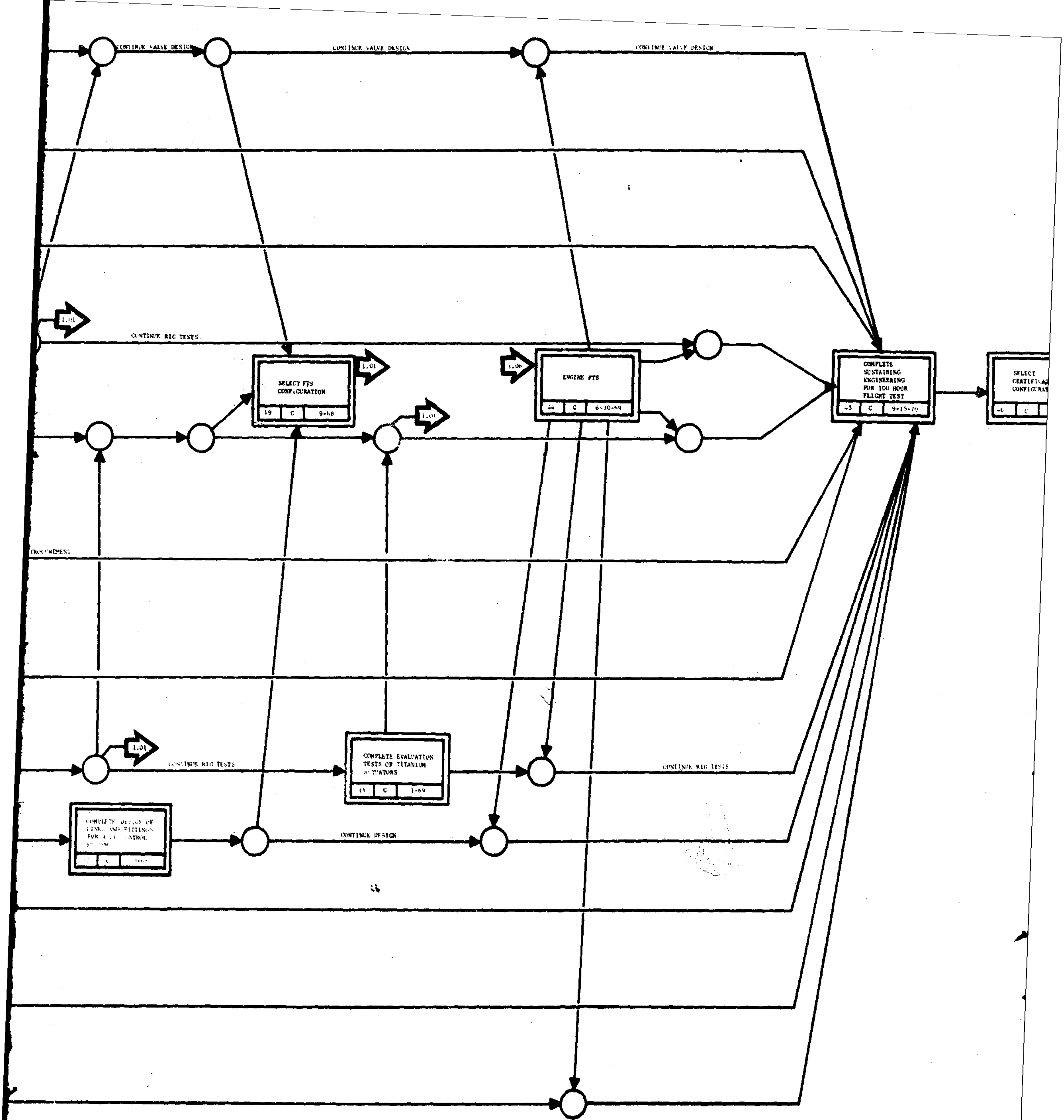
START CALIBRATION TEST OF ACTUATORS

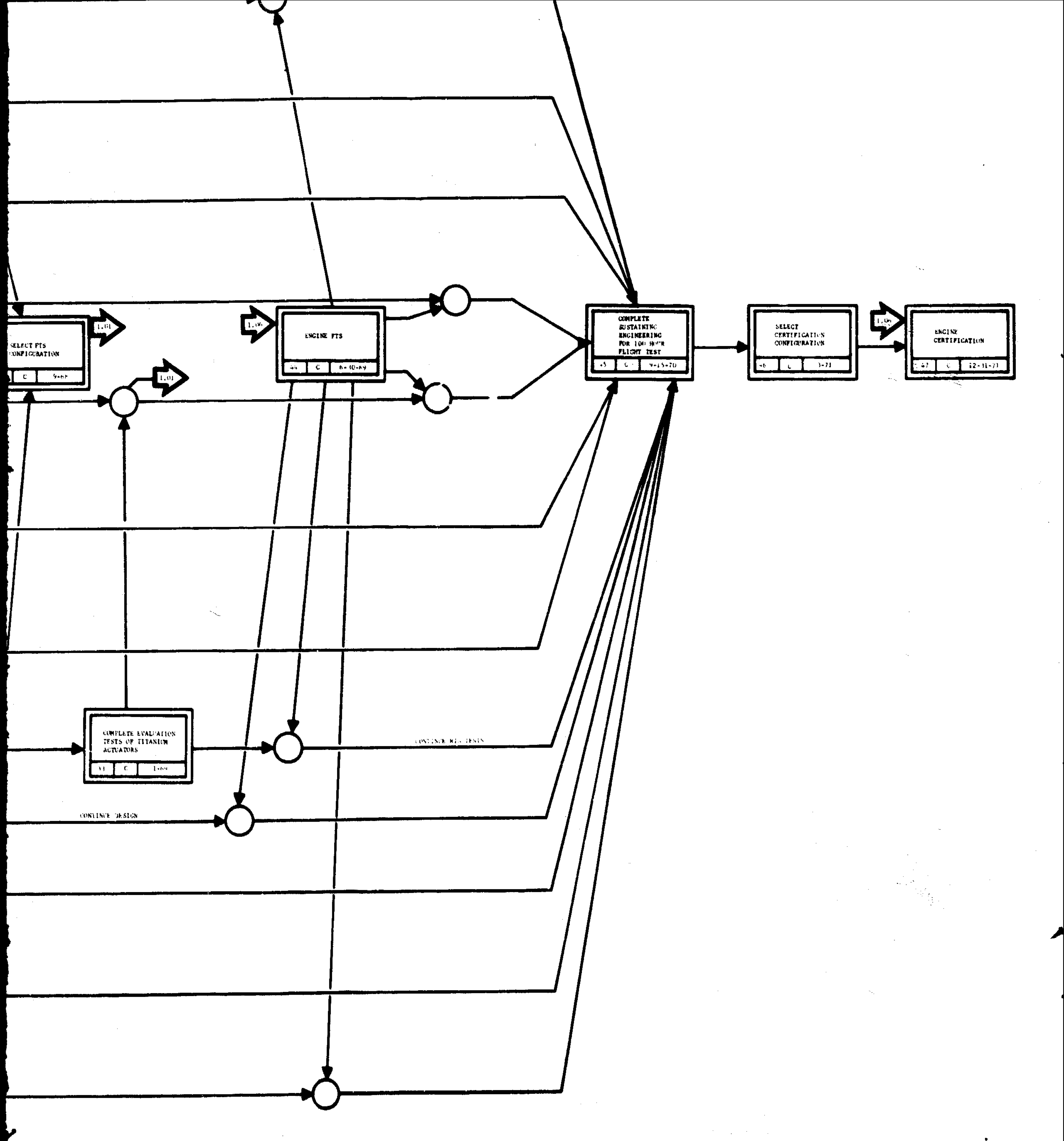
START HEAT TRANSFER TESTS

START HOT ENVIRONMENTAL ENDURANCE TESTS

START CONTAMINATION TESTS

3


CONTINUE VALVE DESIGN
CONTINUE VALVE DESIGN
CONTINUE VALVE DESIGN
1.01
CONTINUE RIG TESTS
SELECT FTS CONFIGURATION
19 C 9-68
1.01
1.01
ENGINE FTS
40 C 6-30-69
COMPLETE SUSTAINING ENGINEERING FOR 100 HOUR FLIGHT TEST
45 C 9-15-70
1.01
CONTINUE RIG TESTS
COMPLETE EVALUATION TESTS OF TITANIUM ACTUATORS
1-69
CONTINUE RIG TESTS
CONTINUE DESIGN



SELECT FTS
CONFIGURATION
C
1.01
1.01
1.06
ENGINE FTS
C
COMPLETE
SUSTAINING
ENGINEERING
FLIGHT TEST
SELECT
CONFIGURATION
ENGINE
CERTIFICATION
COMPLETE EVALUATION
TESTS OF TITANIUM
ACTUATORS
C
CONTINUE DESIGN

5

1.17 LUBRICANTS, LUBRICATION SYSTEM, BEARINGS, SEALS AND GEARS

LUBRICANTS AND LUBRICATION SYSTEM

A continuing program of lubricant investigation including service evaluation will be conducted to promote the development of the highest performance engine oils attainable within acceptable economic limits and to prove their suitability by engine, rig, and laboratory tests. Testing, other than that in the development engines, will be accomplished in closely controlled engine compartment and gearbox system rigs to define the thermal stability characteristics of the lubricant at engine lubrication system temperatures, and to define the tolerance of engine bearing and seal compartments and lubrication system components to the specification lubricants under simulated engine environmental conditions. Sampling and monitoring procedures will be established and maintained on the development engines to provide data to identify potential mechanical problems and to extend the oil use time by eliminating fixed drain periods for the JTF17 engines.

BEARINGS, SEALS, AND GEARS

Bearing, seal, and gearbox testing will be carried out on bearing and seal rigs, complete compartment test rigs and an integrated gearbox - lubrication system rig. Pratt & Whitney Aircraft engine development and flight experience has proved the necessity of exhaustive testing of bearing and seal components in compartment rigs for the success of an engine development and certification program. Bearing, seal, gearbox, and lubricant system performances are dependent on each other and the test program will be formulated with this in mind.

The specific objective of the bearing program will be to evaluate the performance characteristics of all major bearings in the JTF17 engine, including towershaft bearings, compartment thrust bearings and compartment roller bearings. Engine bearings will be overload-tested at simulated environmental conditions to accelerate the evaluation of bearing life. The testing program will be conducted at simulated environmental conditions with the selected lubricant.

It is the specific objective of the seal program to evaluate the performance of the major seal assemblies with the selected lubricant at environmental conditions. Compartment rigs that simulate the engine compartments will continue to be tested utilizing actual JTF17 bearings, seals, scavenge pumps, housings, and associated hardware. These tests will include seal performance, endurance testing, and evaluation of alternative seal materials and designs.

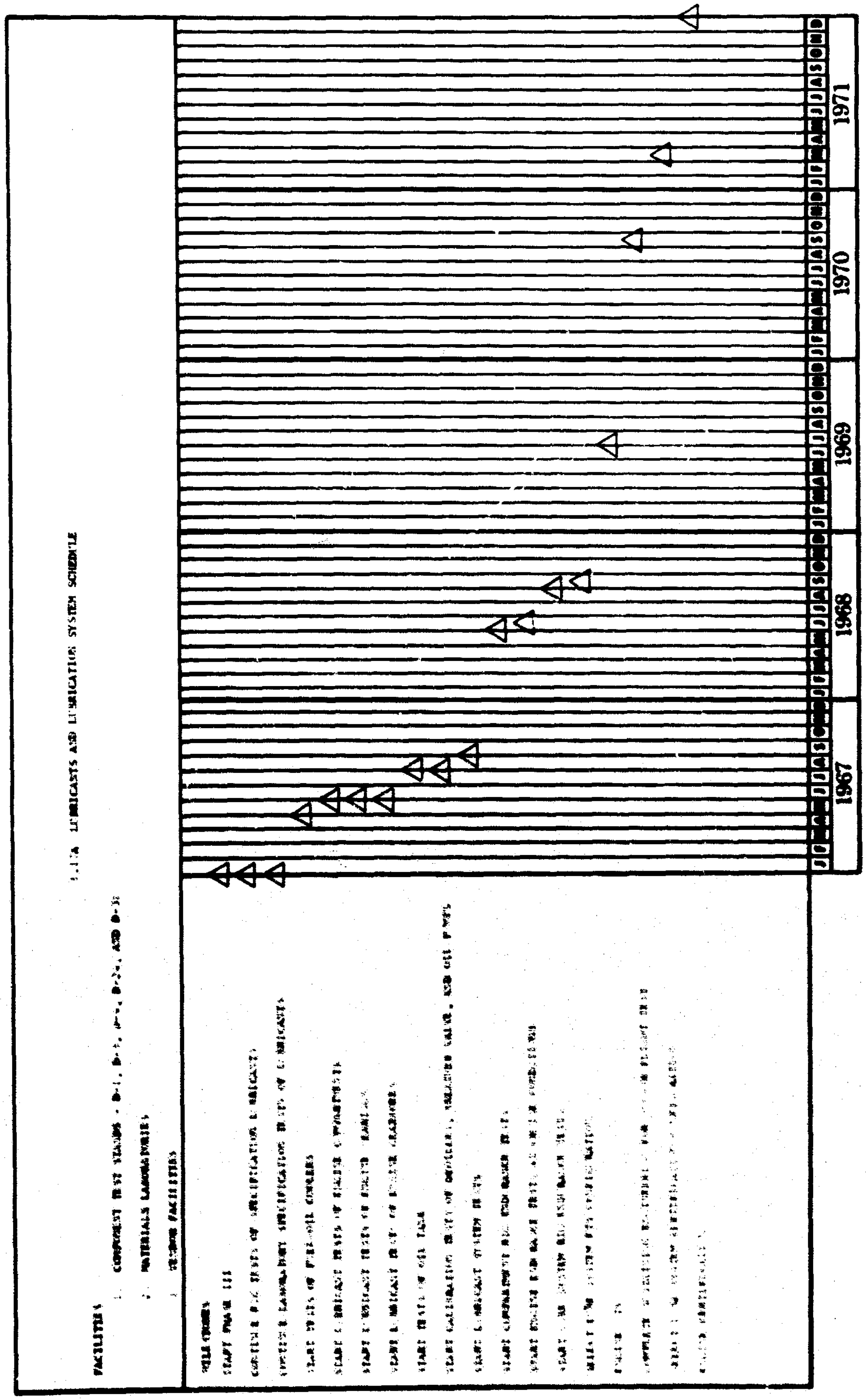
Pratt & Whitney Aircraft engine development and flight experience has shown the value of a gearbox component program which stresses rigorous testing of gearbox configurations under simulated environmental conditions. The JTF17 gearbox test program follows the same type of program as pursued in the J58 gearbox development.

The engine gearboxes consist of the main accessory gearbox, the secondary accessory gearbox, and the power takeoff angle gearbox. The program includes testing of individual gearbox components and complete gearbox assemblies. Each gearbox will undergo endurance testing with and without environmental conditions. In addition, the gearboxes will be tested in an integrated system rig which has proved necessary on previous programs. The integrated system consists of a rig which is capable of running all of the gearboxes along with the associated oil sump, the oil tank, the main oil pump, the fuel-oil coolers, the bearing and seal compartments and oil plumbing. The gearbox accessory drives will be loaded with water brakes and will be tested both at ambient and simulated environmental conditions. The integrated gearbox system rig also will be used to evaluate selected lubricants.

The program will be directed toward completion of FTS and certification testing in the integrated gearbox system prior to completion of the engine Certification Test.

The major milestones, network charts and event dictionaries for the lubricants, lubrication system, bearings, seals, and gears program are shown in figures 33 and 34, respectively.

A detailed description of the lubricants, lubrication system, bearing, seal, and gearbox development is presented in the Test and Certification Plan, Volume III, Report E. Test planning and integration is presented in Test, Volume IV, Report E.



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VII

Figure 33. 1.17 Lubricants Lubrication System, Bearings, Seals, and Gears (Sheet 1 of 2)

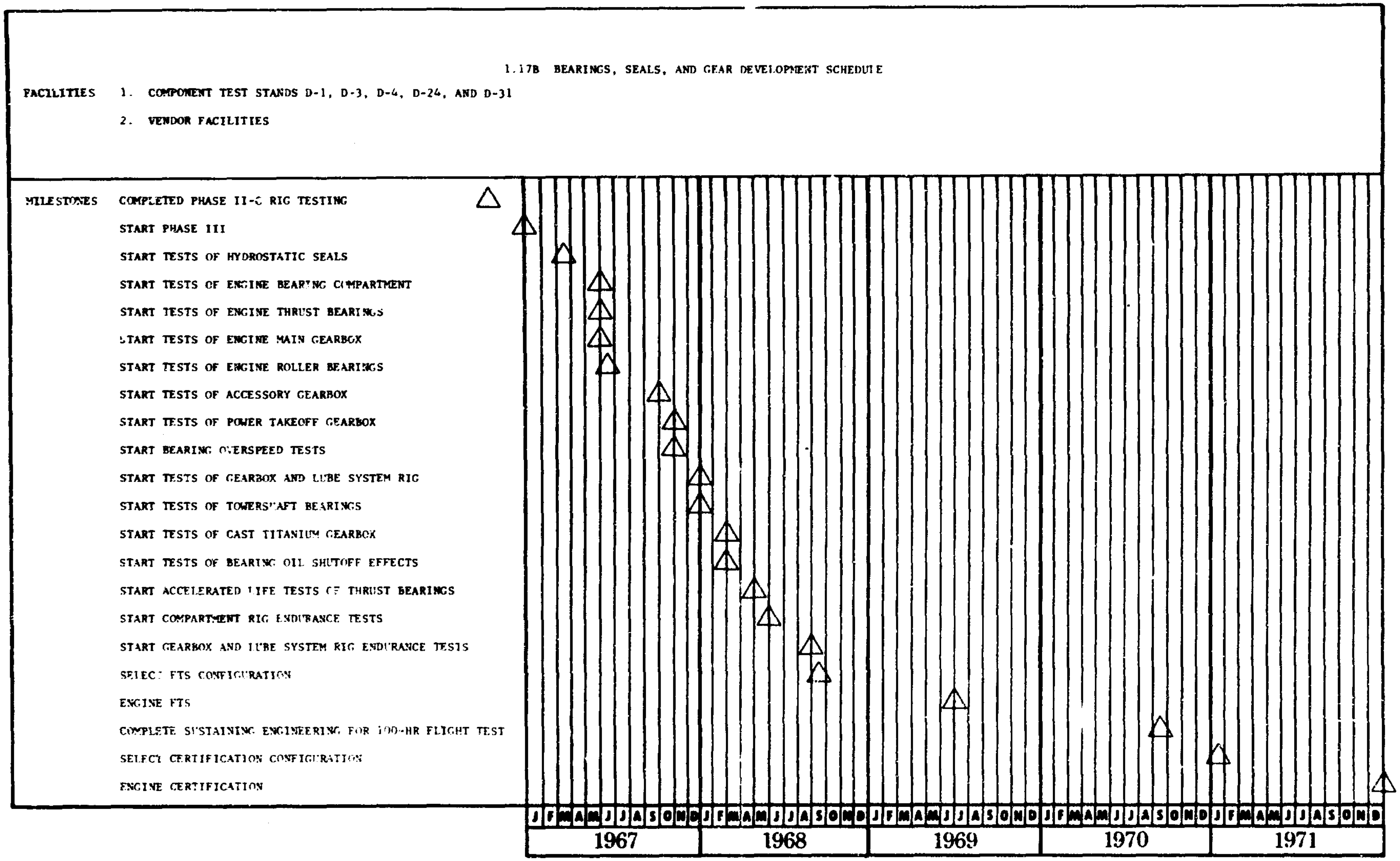

Figure 33. 1.17 Lubricants, Lubrication System, Bearings, Seals, and Gears (Sheet 2 of 2)

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VII

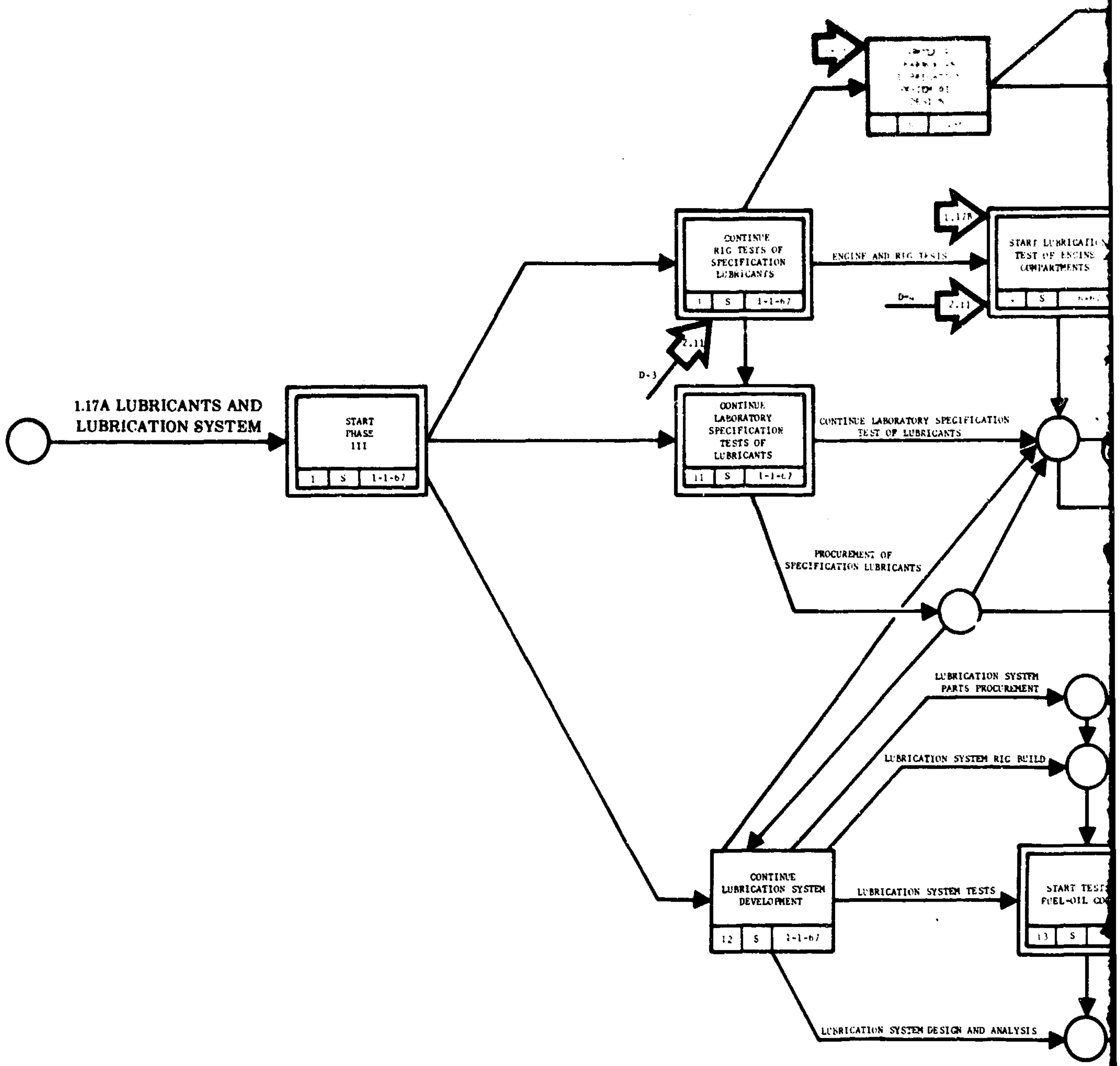
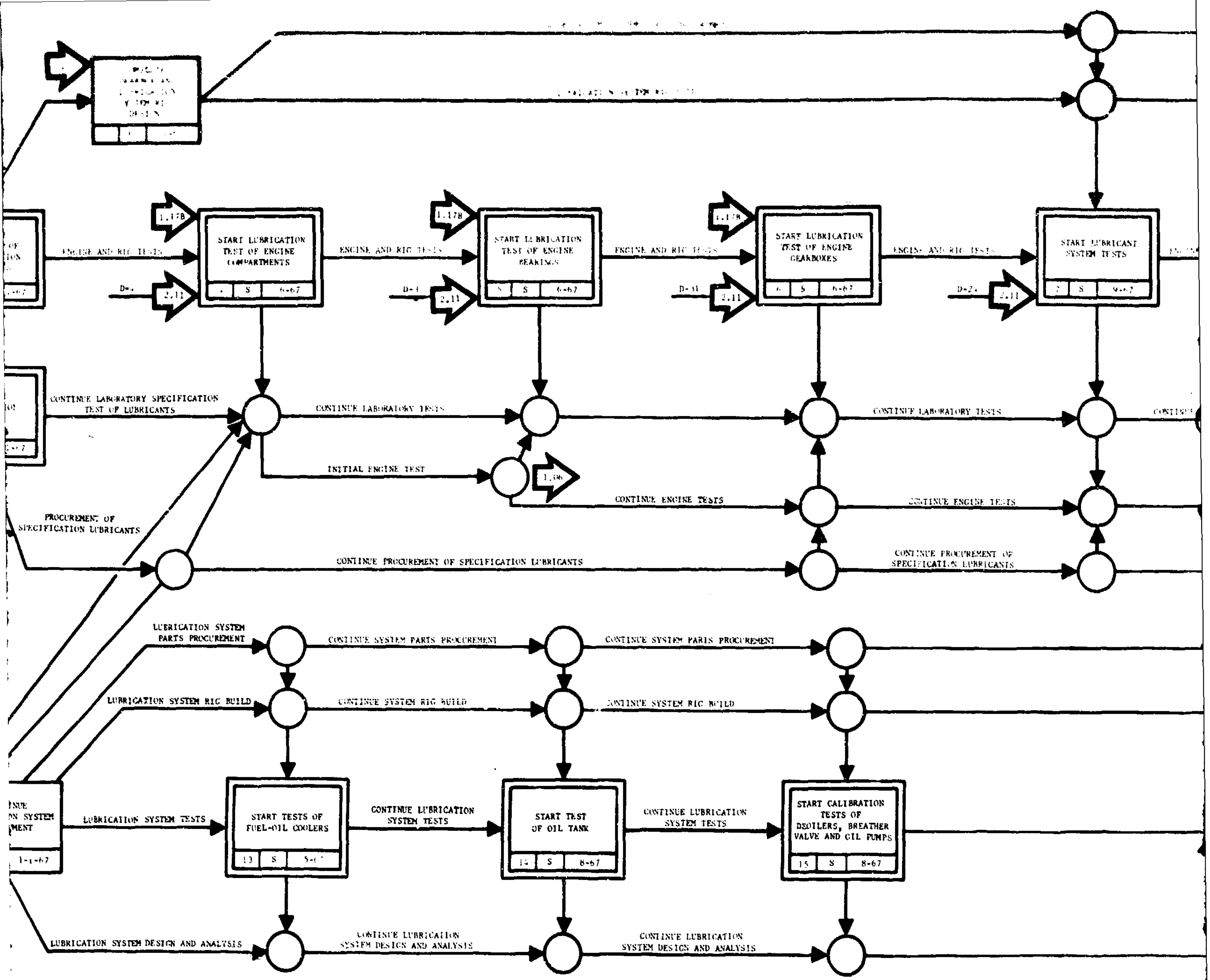


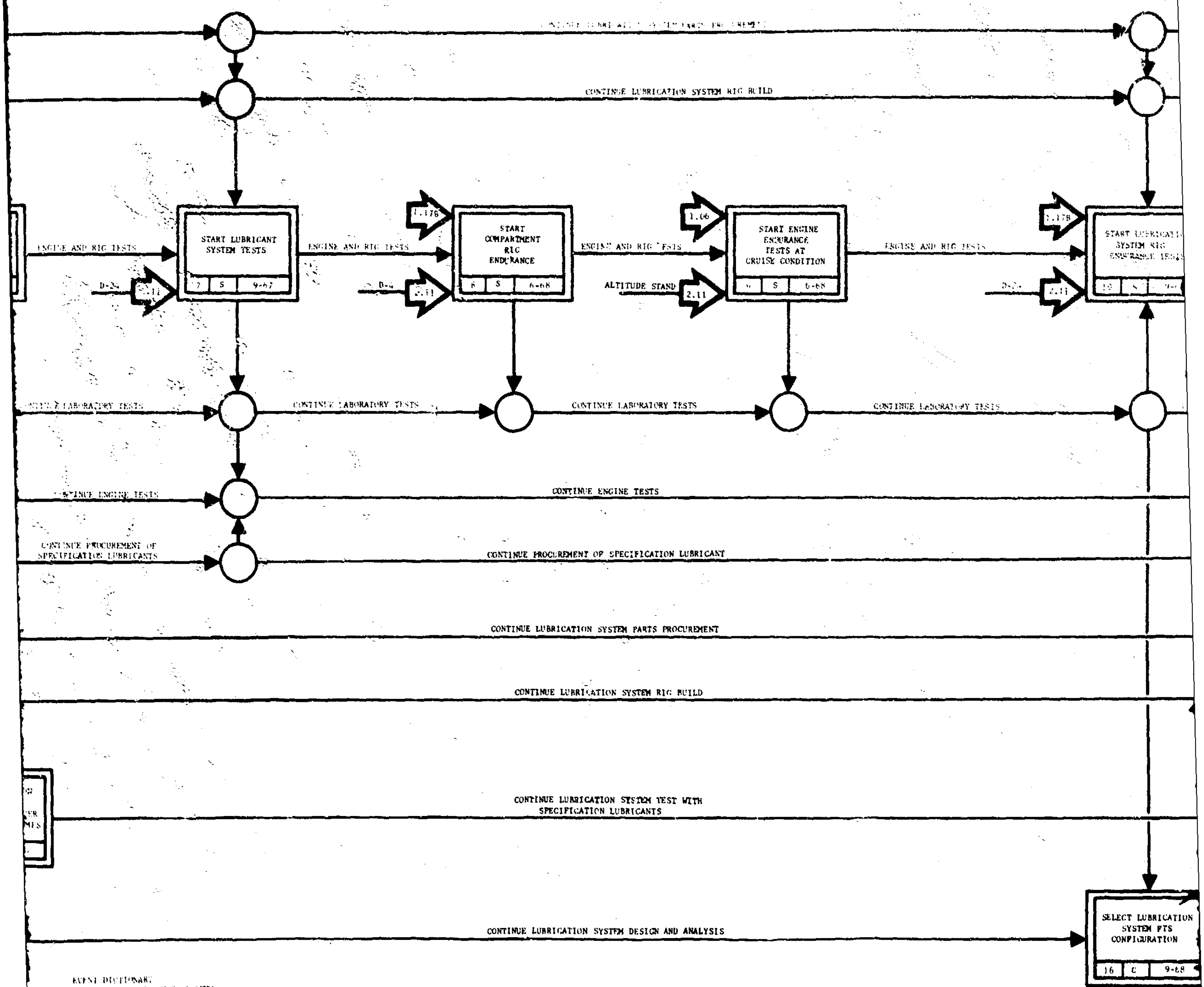
Figure 34. 1.17 Lubricants, Lubrication System, Bearings, Seals, and Gears (Sheet 1 of 2)



EVENT DICTIONARY
1.17A LUBRICANTS AND LUBRICATION SYSTEM

Event Number	Description and Criteria
1	START PHASE III Start of Phase III. Phase III go-ahead received from FAA.
2	COMPLETE GEARBOX AND LUBE SYSTEM RIG DESIGN Complete design modification of engine parts for rig use. Design modification drawings released.
3	CONTINUE RIG TESTS OF SPECIFICATION LUBRICANTS Continue design selection testing of specification lubricants in engine component test rigs at simulated engine conditions. Phase III go-ahead received from FAA.
4	START LUBRICANT TESTS OF ENGINE COMPARTMENTS Start initial design selection testing of specification lubricants in engine compartment rig. Rig delivered to test.
5	START LUBRICANT TESTS OF ENGINE BEARINGS Start initial design selection test of specification lubricants in bearing test rig. Rig delivered to test.
6	START LUBRICANT TEST OF ENGINE GEARBOXES Start initial design selection test of specification lubricants in engine gearboxes. Gearbox rig delivered to test.
7	START LUBRICANT SYSTEM TESTS Start initial design selection lubricant system tests in lubrication system rig. Rig delivered to test.
8	START COMPARTMENT RIG ENDURANCE TESTS Start durability test of specification lubricants in engine compartment rig. Rig delivered to test.
9	START ENGINE ENDURANCE TESTS AT CRUISE CONDITIONS Reference engine network 1.06 for description and criteria.
10	START LUBRICANT SYSTEM RIG ENDURANCE TESTS Start initial durability tests of specification lubricants in gearbox and lubrication System Rig at simulated engine mission cycle conditions. Rig delivered to test.
11	CONTINUE LABORATORY SPECIFICATION TESTS OF LUBRICANTS Continue design selection laboratory testing of specification lubricants. Phase III go-ahead received from FAA.
12	CONTINUE LUBRICATION SYSTEM DEVELOPMENT [illegible] Phase III go-ahead received from FAA.
13	START TEST OF FUEL-OIL COOLERS [illegible] Rig delivered to test.
14	START TEST OF OIL TANK [illegible] Rig delivered to test.

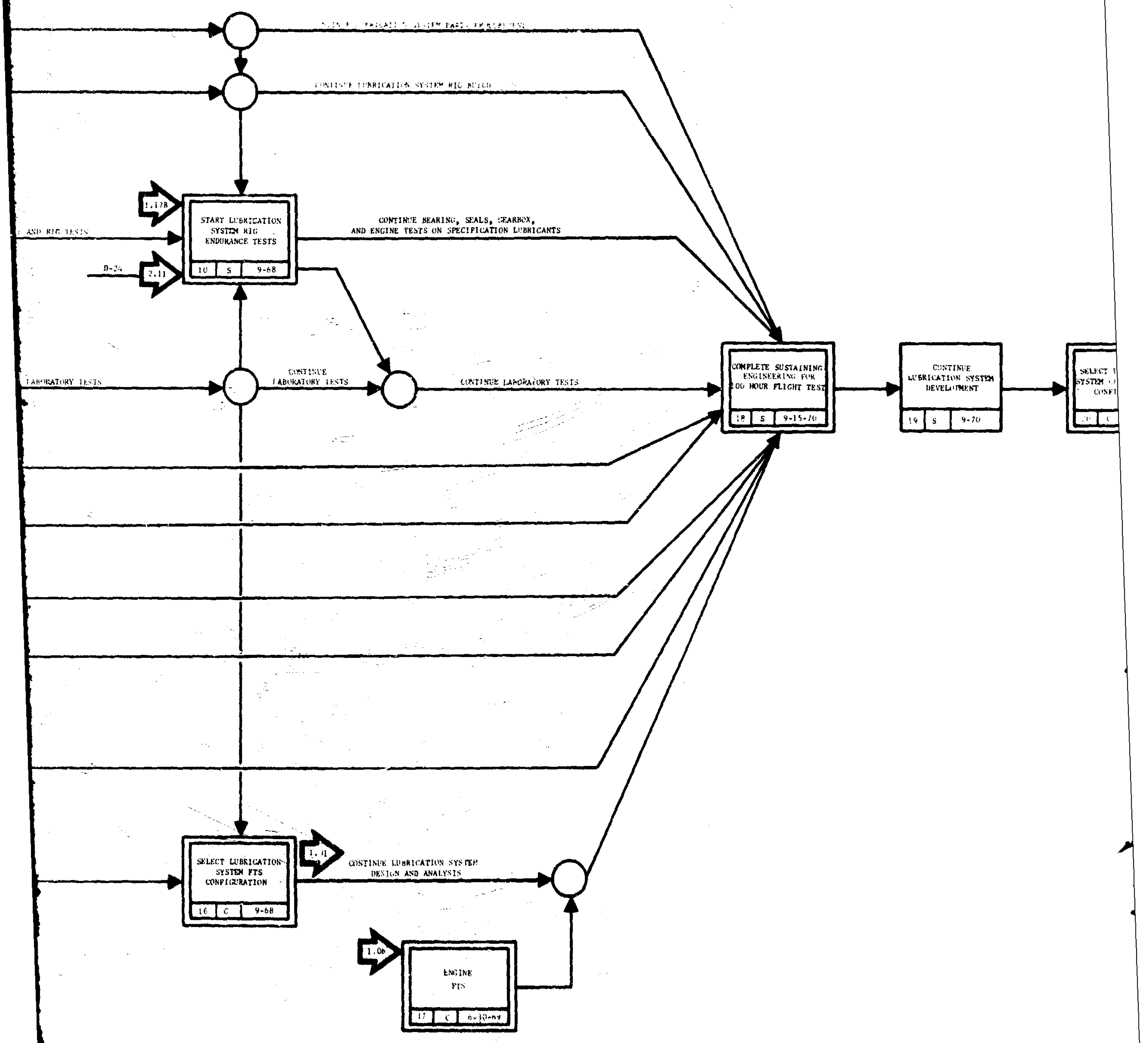
Gears



EVENT DICTIONARY
1.17A LUBRICANTS AND LUBRICATION SYSTEM

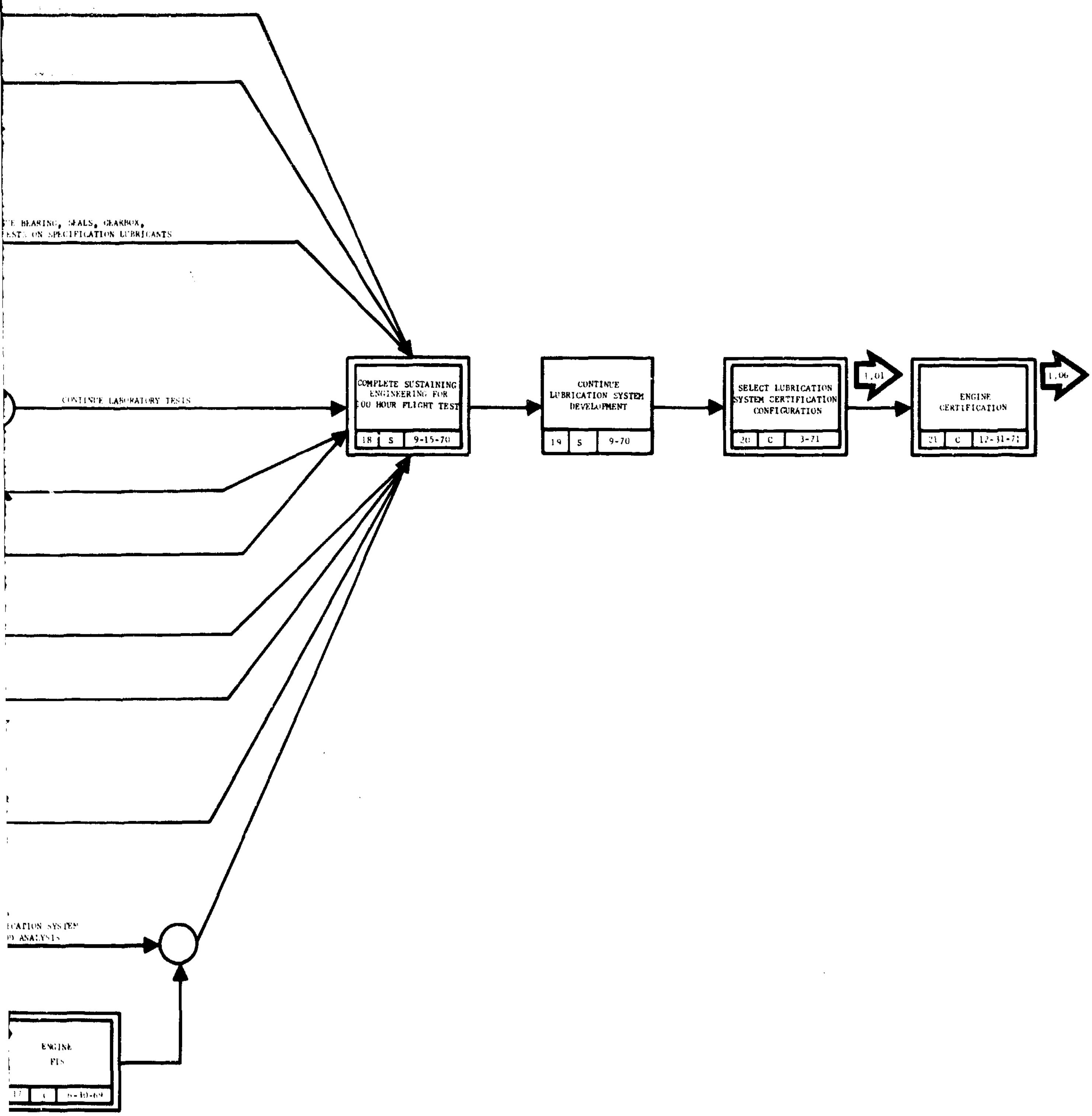
Description and Criteria	Event Number	Description and Criteria
START COMPARTMENT RIG ENDURANCE TESTS Start durability test of specification lubricants in engine compartment rig. Rig delivered to test.	15	**START CALIBRATION TESTS OF DE-OILERS, BREATHER VALVE AND OIL PUMPS** Start initial performance tests of the engine deoiler, breather pressurizing valve and oil pump. Rigs delivered to test.
START ENGINE ENDURANCE TESTS AT CRUISE CONDITIONS Reference engine network 1.06 for description and criteria.	16	**SELECT LUBRICATION SYSTEM FTS CONFIGURATION** Selection of the lubricant and lubrication system configuration to be used in FTS engine tests. Completion of design of lubrication system configuration to be used in engine FTS testing.
START LUBRICANT SYSTEM RIG ENDURANCE TESTS Start [illegible] durability tests of specification lubricants [illegible] lubrication system. Rig at simulated engine mission cycle conditions. Rig delivered to test.	17	**ENGINE FTS** Reference engine network 1.06 for description and criteria.
CONTINUE LABORATORY SPECIFICATION TESTS OF LUBRICANTS [illegible] Phase III [illegible] received from FAA.	18	**COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST** End of Phase III. Completion of 100 hours of flight test.
CONTINUE LUBRICATION SYSTEM DEVELOPMENT [illegible]	19	**CONTINUE LUBRICATION SYSTEM DEVELOPMENT** Start Phase IV lubrication system program [illegible] from Phase III. Phase IV go-ahead received from FAA.
[illegible]	[illegible]	**SELECT LUBRICANT SYSTEM CERT. CONFIGURATION** [illegible]
[illegible]		**ENGINE CERTIFICATION** [illegible]

3



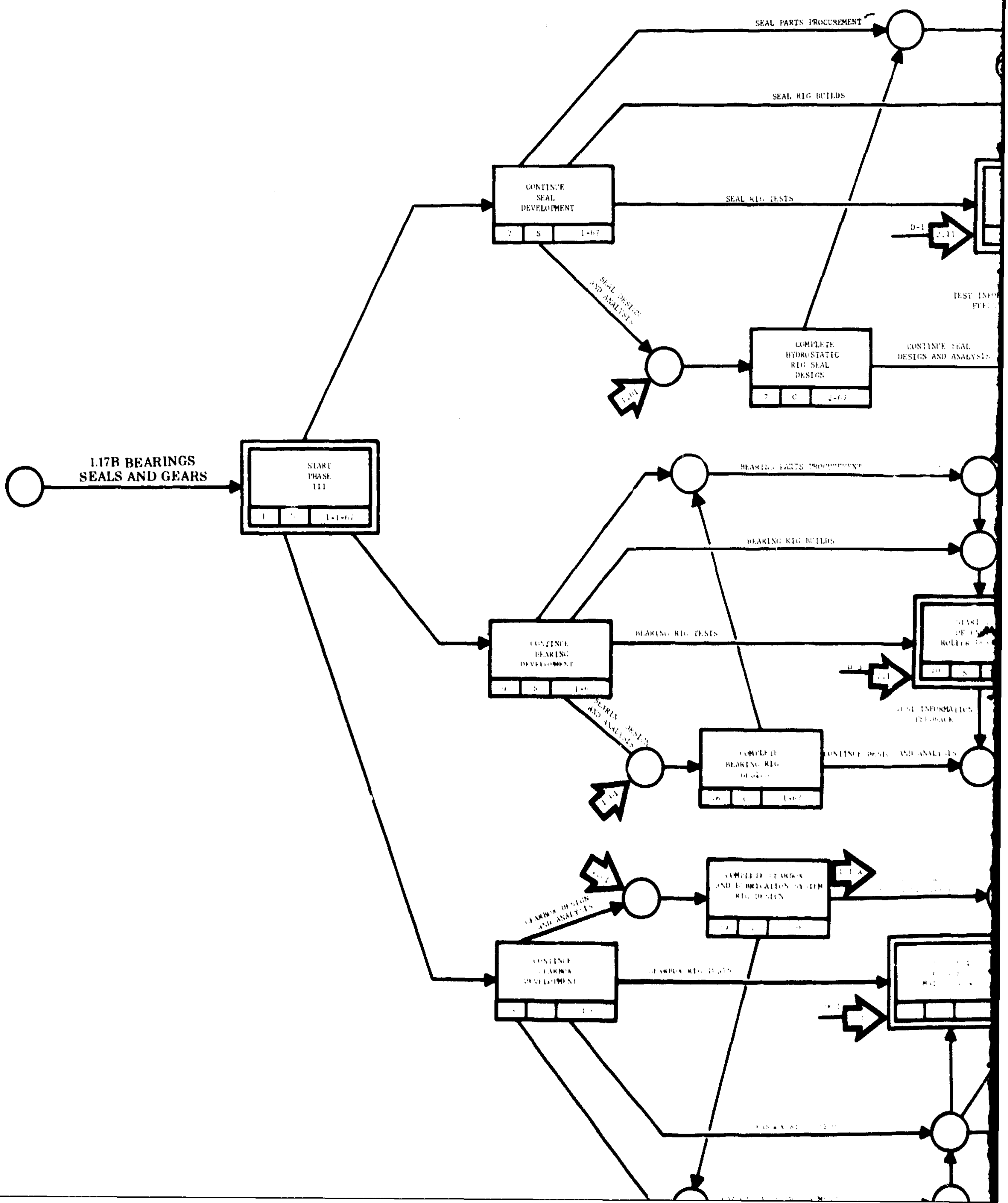
CONTINUE LUBRICATION SYSTEM RIG BUILD
START LUBRICATION SYSTEM RIG ENDURANCE TESTS
1.17B
AND RIG TESTS
D-24
2.11
10 S 9-68
CONTINUE BEARING, SEALS, GEARBOX, AND ENGINE TESTS ON SPECIFICATION LUBRICANTS
LABORATORY TESTS
CONTINUE LABORATORY TESTS
CONTINUE LABORATORY TESTS
COMPLETE SUSTAINING ENGINEERING FOR 200 HOUR FLIGHT TEST
18 S 9-15-70
CONTINUE LUBRICATION SYSTEM DEVELOPMENT
19 S 9-70
SELECT LUBRICATION SYSTEM FTS CONFIGURATION
16 C 9-68
CONTINUE LUBRICATION SYSTEM DESIGN AND ANALYSIS
1.06
ENGINE FTS
17 C 6-30-69

4



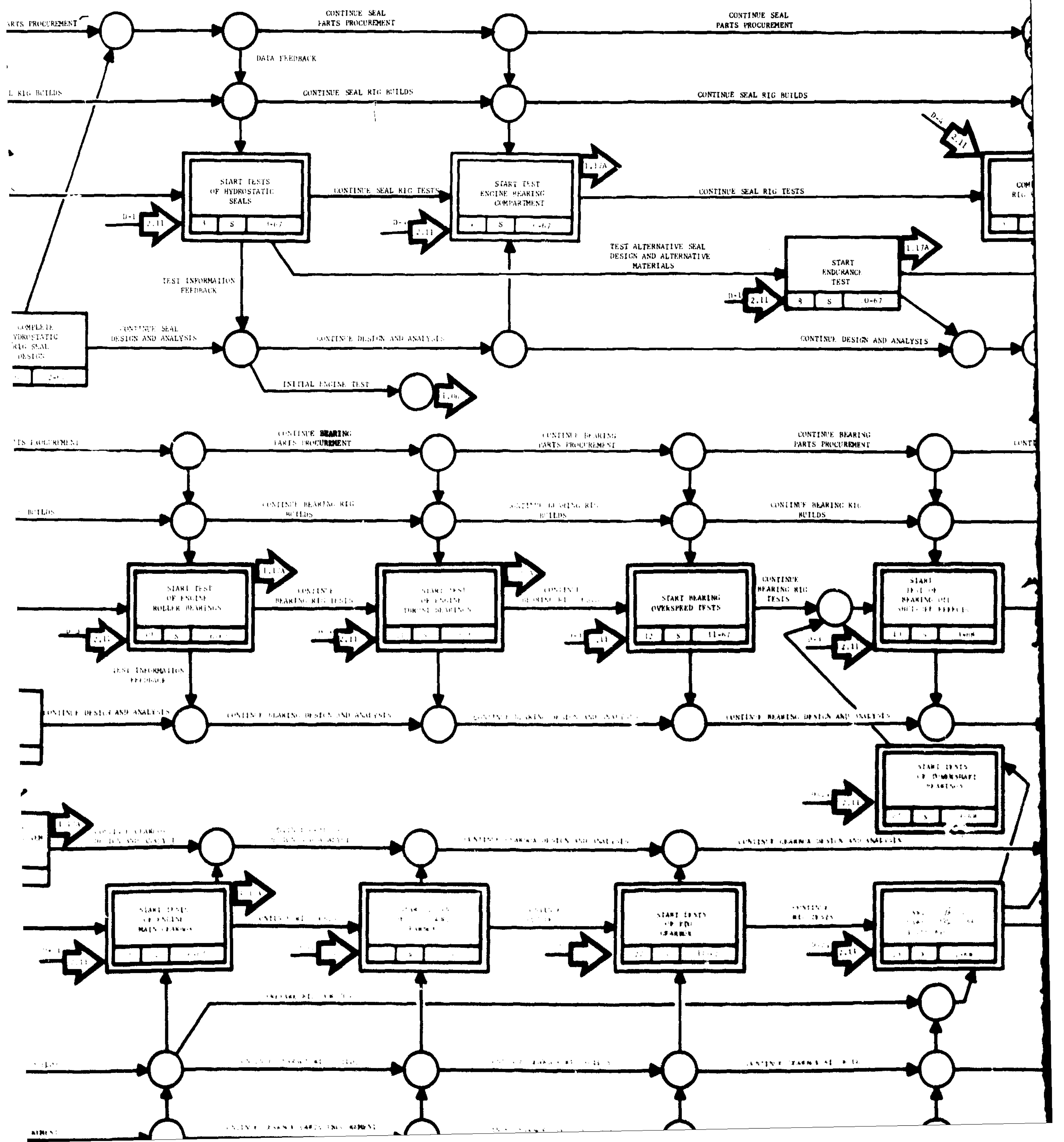
CONTINUE LABORATORY TESTS
COMPLETE SUSTAINING ENGINEERING FOR
18
S
9-15-70
CONTINUE LUBRICATION SYSTEM DEVELOPMENT
19
S
9-70
SELECT LUBRICATION SYSTEM CERTIFICATION CONFIGURATION
20
C
3-71
ENGINE CERTIFICATION
21
C
12-31-71

5


1.17B BEARINGS
SEALS AND GEARS
START
PHASE
III
CONTINUE
SEAL
DEVELOPMENT
SEAL PARTS PROCUREMENT
SEAL RIG BUILDS
SEAL RIG TESTS
SEAL DESIGN
AND ANALYSIS
COMPLETE
HYDROSTATIC
RIG SEAL
DESIGN
CONTINUE SEAL
DESIGN AND ANALYSIS
BEARING RIG BUILDS
BEARING RIG TESTS

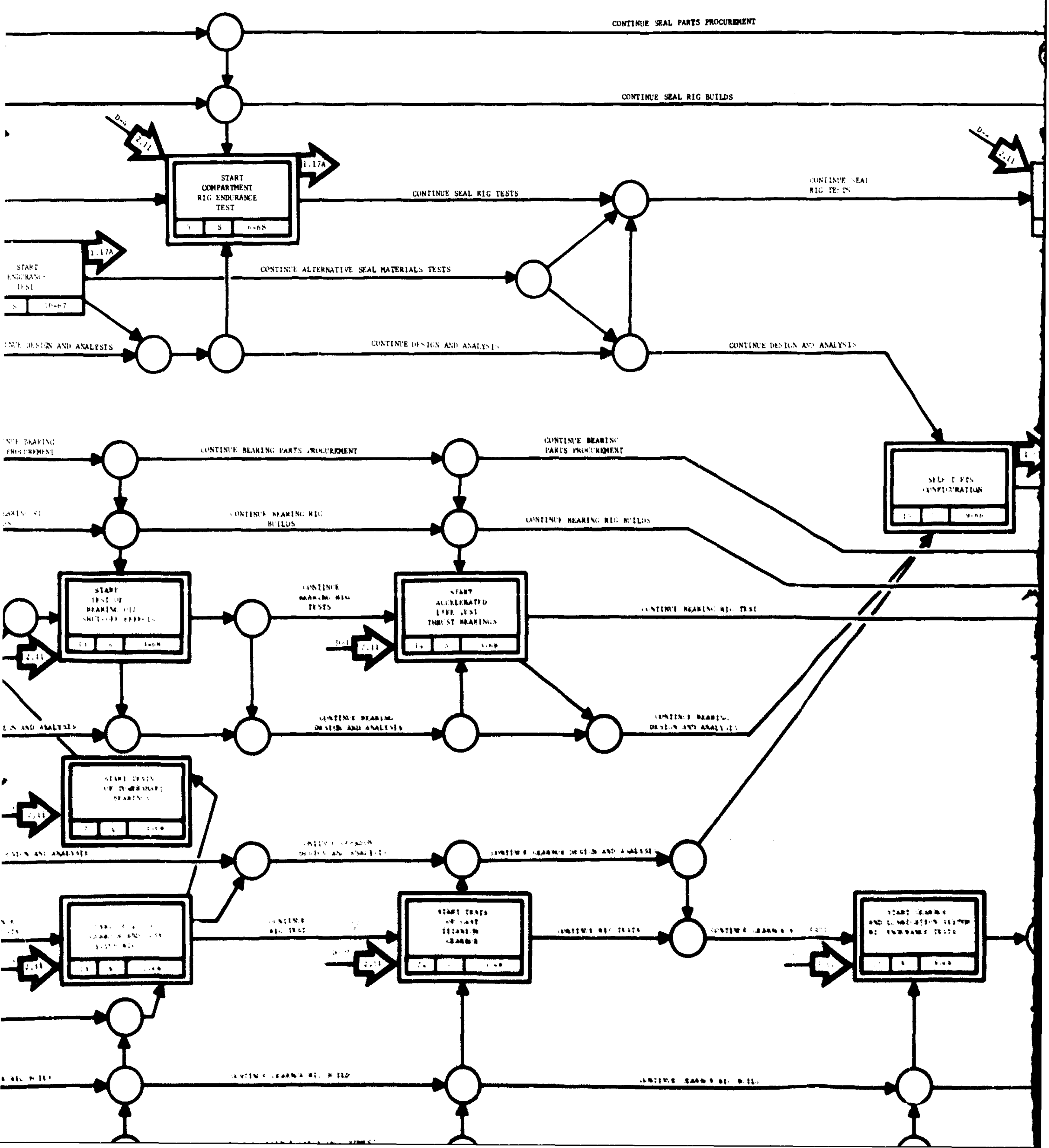
2

1.17B


CONTINUE SEAL PARTS PROCUREMENT
DATA FEEDBACK
CONTINUE SEAL RIG BUILDS
START TESTS OF HYDROSTATIC SEALS
CONTINUE SEAL RIG TESTS
START TEST ENGINE BEARING COMPARTMENT
1.17A
TEST ALTERNATIVE SEAL DESIGN AND ALTERNATIVE MATERIALS
START ENDURANCE TEST
2.11
TEST INFORMATION FEEDBACK
CONTINUE DESIGN AND ANALYSIS
INITIAL ENGINE TEST
CONTINUE BEARING PARTS PROCUREMENT
CONTINUE BEARING RIG BUILDS
START TEST OF ENGINE ROLLER BEARINGS
START BEARING OVERSPEED TESTS
CONTINUE BEARING RIG TESTS
CONTINUE BEARING DESIGN AND ANALYSIS
START TESTS OF GEARS

3

1.17B Bearings, Seals, and Gears



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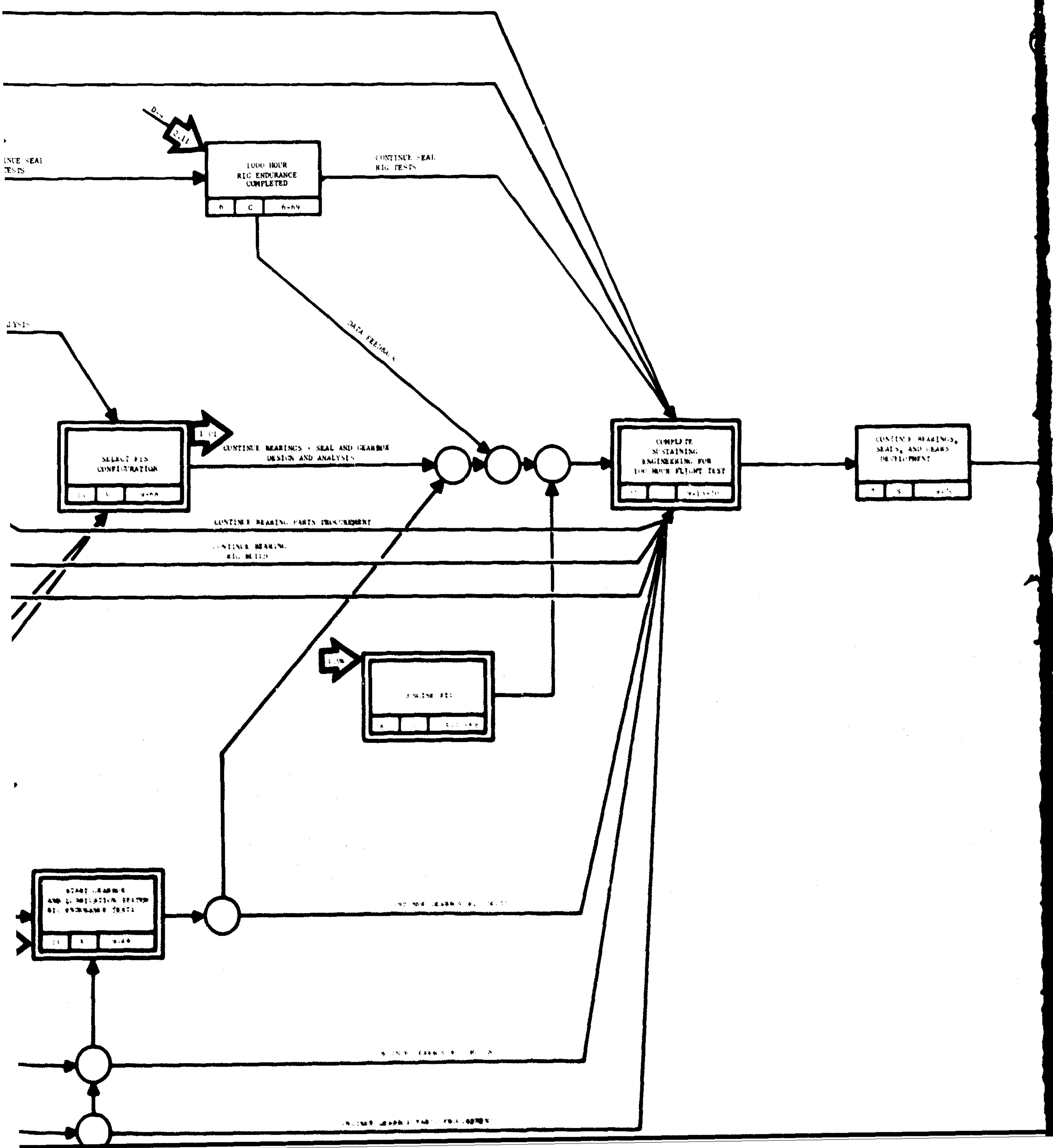
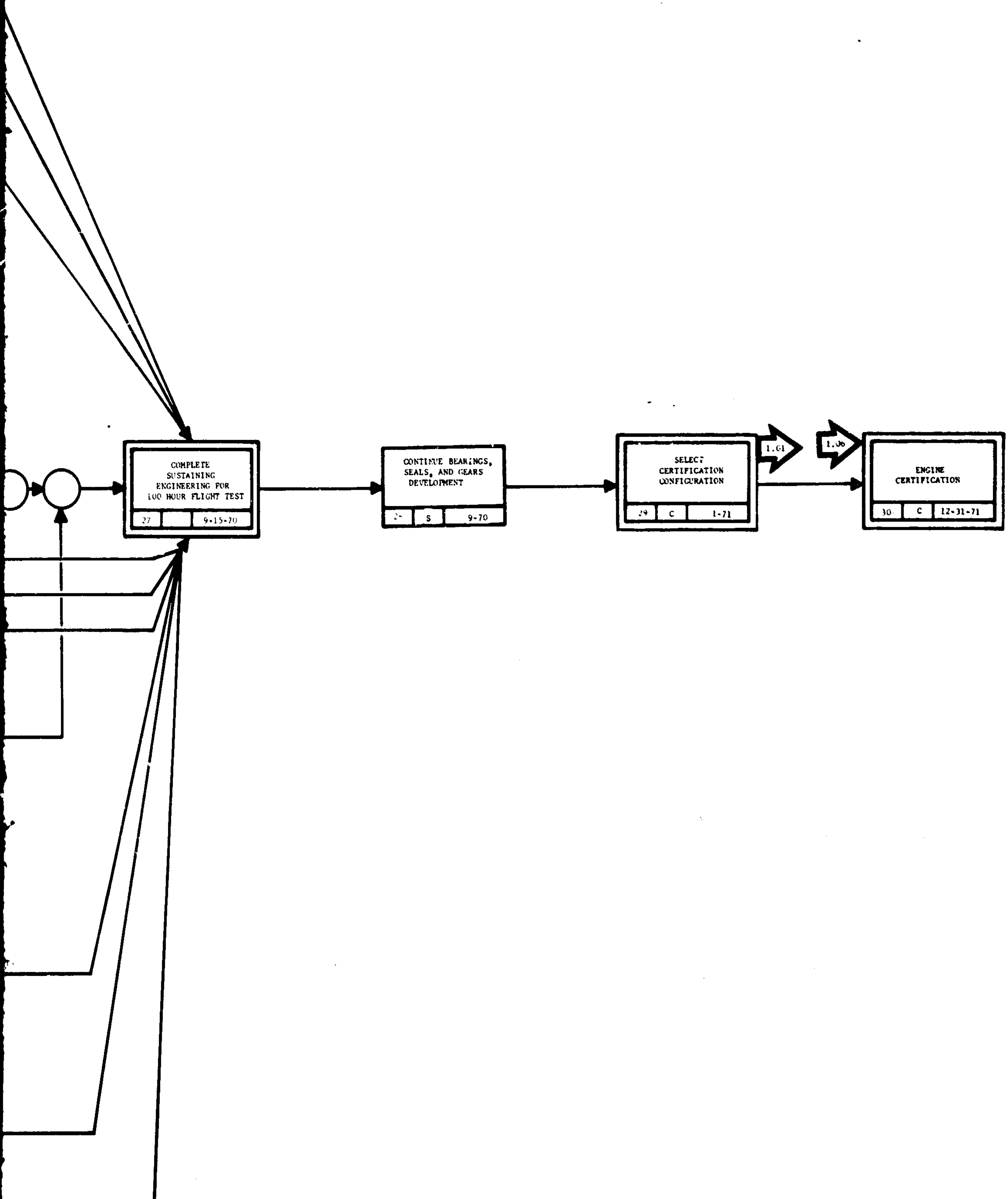

1000 HOUR
RIG ENDURANCE
COMPLETED
6
C
6-69
CONTINUE SEAL
RIG TESTS
DATA FEEDBACK
SELECT FTS
CONFIGURATION
9-68
CONTINUE BEARINGS - SEAL AND GEARBOX
DESIGN AND ANALYSIS
CONTINUE BEARING PARTS PROCUREMENT
CONTINUE BEARING
RIG BUILD
COMPLETE
SUSTAINING
ENGINEERING FOR
100 HOUR FLIGHT TEST
CONTINUE BEARINGS,
SEALS, AND GEARS
DEVELOPMENT
S

5


COMPLETE SUSTAINING ENGINEERING FOR 100 HOUR FLIGHT TEST
27
9-15-70
CONTINUE BEARINGS, SEALS, AND GEARS DEVELOPMENT
S
9-70
SELECT CERTIFICATION CONFIGURATION
29
C
1-71
ENGINE CERTIFICATION
30
C
12-31-71

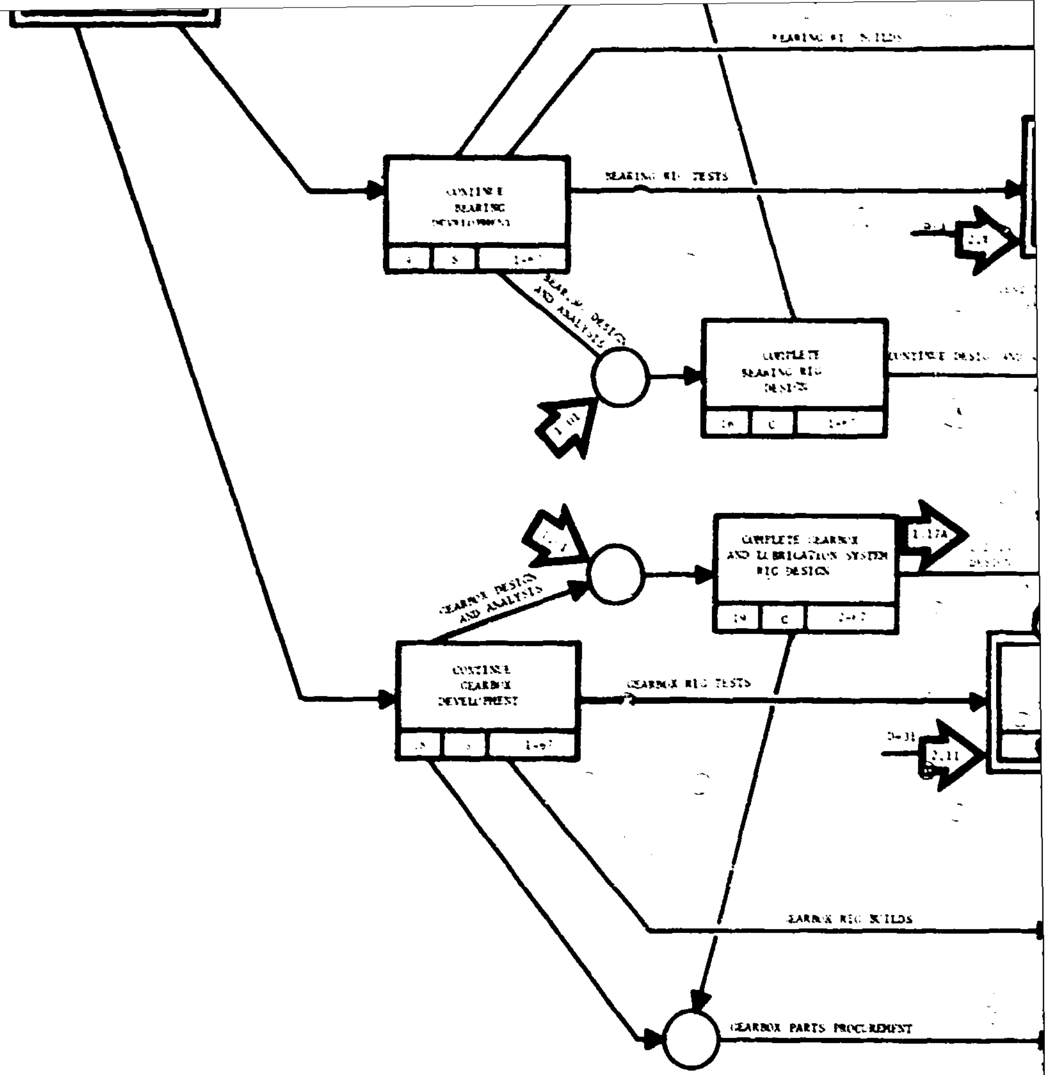
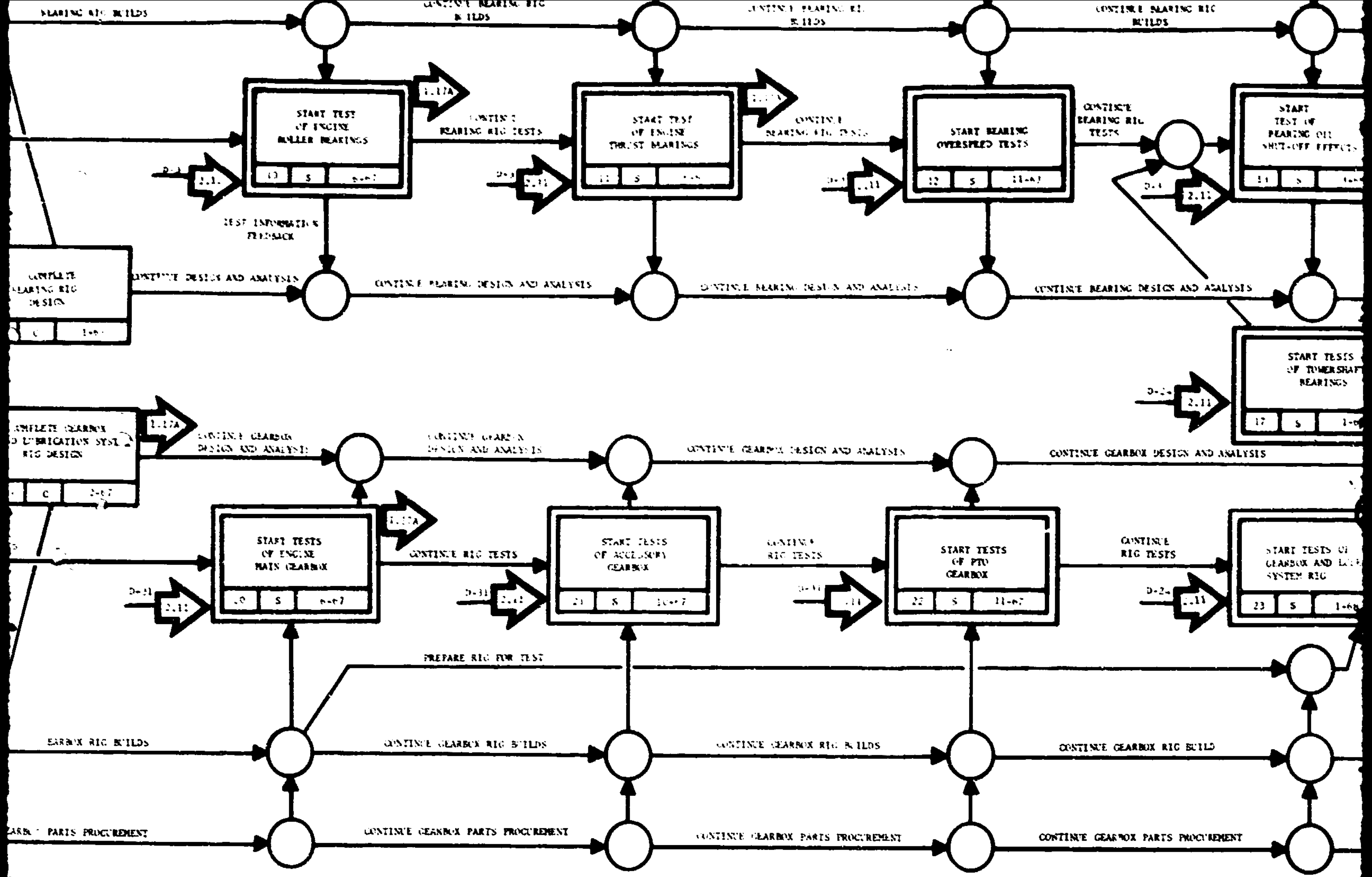
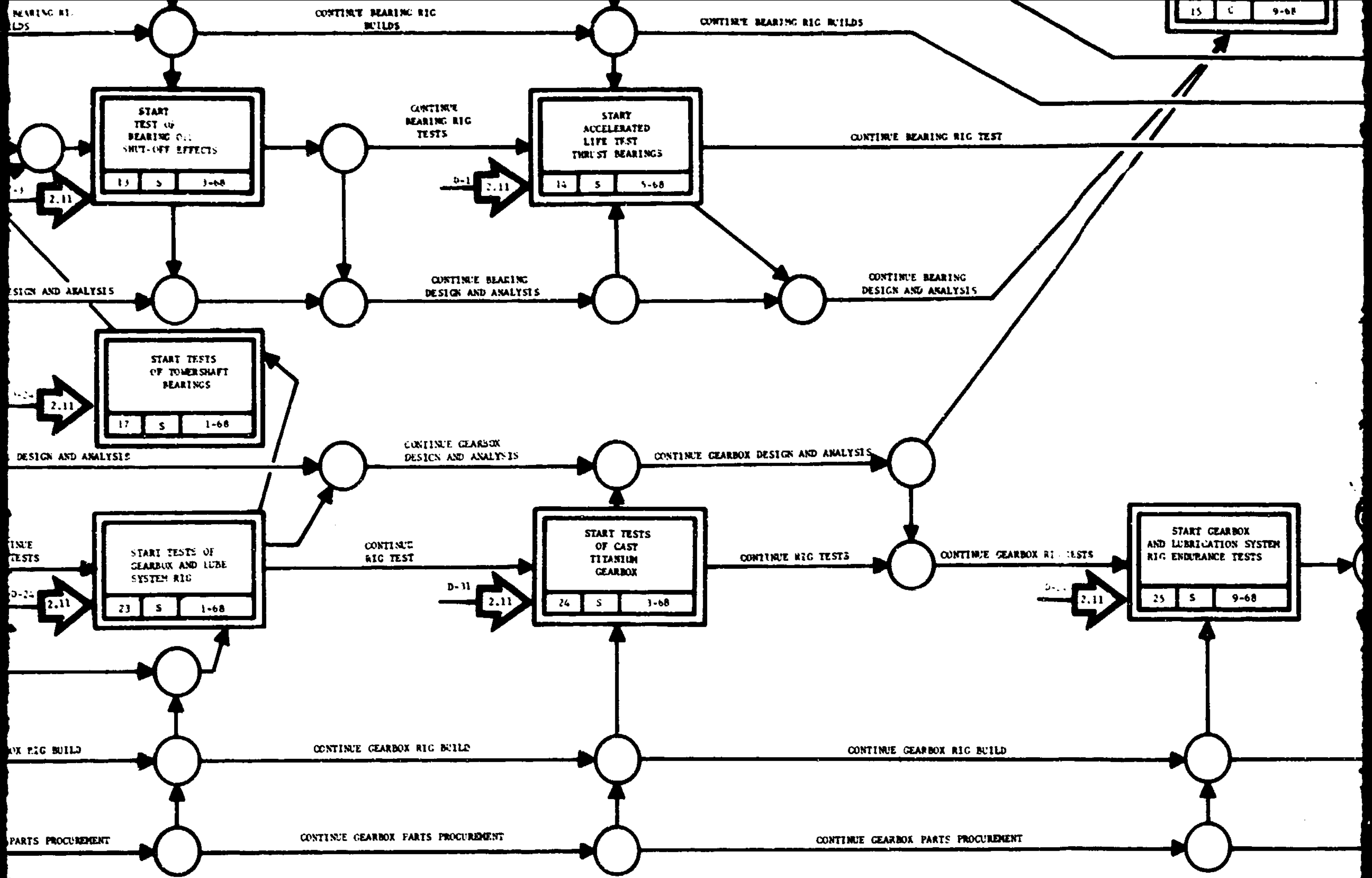


Figure 34. 1.17 Lubricants, Lubrication System, Bearings, Seals, and Gears (Sheet 2 of 2)



Event Number	Description and Criteria	Event Number	Description and Cr[iteria]
[illegible]	**START PHASE III** Start of Phase III. Phase III [illegible] FAA.	10	**START TESTS OF ENGINE ROLLER** [illegible] Initial design selection test [illegible] roller bearings at si[illegible] and rotor speed condit[illegible] delivered to test.
[illegible]	**CONTINUE SEAL DEVELOPMENT** Continue [illegible] hydrostat[ic] seals. Phase III [illegible] FAA.	11	**START TESTS OF ENGINE THRUST** [illegible] Initial design selection test [illegible] thrust bearings at simulated [illegible] rotor speed conditions. [illegible] test.
[illegible]	**START [illegible] HYDROSTATIC SEALS** Initial [illegible] selection test [illegible] static seals. Rig delivered to test.	12	**START BEARING OVERSPEED TES[TS]** Start initial [illegible] speed conditions. Rig [illegible]
[illegible]	**START TEST OF ENGINE BEARING COMPARTMENT** Start initial structural tests [illegible] bearing [illegible] compartment rig at simulated [illegible] Rig delivered to test.	13	**START TEST OF BEARING OIL** [illegible] Start initial bearing [illegible] determine the bearing reli[ability] [illegible] Rig deli[vered]
[illegible]	**START COMPARTMENT RIG ENDURANCE TESTS** Start [illegible] test [illegible] bearing [illegible] compartment seal rig at simulated engine conditions. Completion of initial bearing and seal design selection and structural tests and rig delivered to test.	14	**START ACCELERATED LIFE TESTS** Start initial thrust bearing [illegible] determine the bearing relia[bility] [illegible] to test.
6	**1000-HOUR RIG ENDURANCE COMPLETE** Complete [illegible] initial 1000-hour [illegible] test of selected engine compartment [illegible] bearing [illegible] compartment seal rig at simulated [illegible] mission cycles. Completion of endurance test.	15	**SELECT PTS CONFIGURATION** Selection of the bearings, se[als] configuration to be used in P[TS]. Completion of design of bear[ing] gearbox configuration to be [illegible] testing.
[illegible]	**COMPLETE HYDROSTATIC SEAL RIG DESIGN** Complete detailed layouts for fabrication of rig parts. Detailed layouts are released.	16	**COMPLETE BEARING RIG DESIGN** Complete detailed layouts [illegible] rig parts. Detailed layouts [illegible]
8	**START ENDURANCE TESTS** Start durability tests of each hydrostatic se[al] design at simulated engine mission cycle conditions. Initial design selection complete and rig delivered to test.	17	**START TESTS OF TOWERSHAFT BEA[RINGS]** Initial structural test [illegible] bearings at simulated engine [illegible] and oiling configuration. R[illegible]
9	**CONTINUE BEARING DEVELOPMENT** Continue the development of the engine bearings. Phase III go-ahead received from FAA.	18	**CONTINUE GEARBOX DEVELOPMENT** Continue the development [illegible] Phase III go-ahead received [illegible]

ars



EVENT DICTIONARY
1.?7B BEARINGS, SEALS AND GEARS

Description and Criteria	Event Number	Description and Criteria	Event Number	Description and Criteria

START TESTS OF ENGINE ROLLER BEARINGS
Initial design selection test of engine main shaft roller bearings at simulated engine loads, oiling and rotor speed conditions. Rig delivered to test.

START TESTS OF ENGINE THRUST BEARINGS
Initial design selection tests of engine main thrust bearings at simulated engine loads, oiling, and rotor speed conditions. Rig delivered to test.

START BEARING OVERSPEED TESTS
Start initial bearing structural tests at overspeed conditions. Rig delivered to test.

START TEST OF BEARING OIL SHUTOFF EFFECTS
Start initial bearing oil shutoff tests to determine the bearing reliability as a function of oil shutoffs. Rig delivered to test.

START ACCELERATED LIFE TESTS OF THRUST BEARINGS
Start initial thrust bearing B10 Life tests to determine the bearing reliability. Rig delivered to test.

SELECT FTS CONFIGURATION
Selection of the bearings, seals and gearbox configuration to be used in FTS engine test. Completion of design of bearings, seals and gearbox configuration to be used in engine FTS testing.

COMPLETE BEARING RIG DESIGN
Complete detailed layouts for fabrication of rig parts. Detailed layouts are released.

START TESTS OF TOWERSHAFT BEARINGS
Initial structural test of engine towershaft bearings at simulated engine loads, altitude, and oiling configuration. Rig delivered to test.

CONTINUE GEARBOX DEVELOPMENT
Continue the development of the engine gearbox. Phase III go-ahead received from FAA.

19 **COMPLETE GEARBOX AND LUBRICATION SYSTEM RIG DESIGN**
Complete detailed modification of engine parts for rig use. Design modification drawings released.

20 **START TEST OF ENGINE MAIN GEARBOX**
Initial structural test of fabricated titanium engine main gearbox. Rig delivered to test.

21 **START TEST OF ACCESSORY GEARBOX**
Initial structural test of fabricated titanium engine accessory gearbox. Rig delivered to test.

22 **START TESTS OF PTO GEARBOX**
Start initial structural test of fabricated titanium engine Power Takeoff gearbox. Rig delivered to test.

23 **START TESTS OF GEARBOX AND LUBE SYSTEM RIG**
Start initial testing of the integrated engine gearbox and lubrication system in a "bladeless" engine rig. Rig delivered to test.

24 **START TEST OF CAST TITANIUM GEARBOX**
Initial design selection test of a cast titanium gearbox. Rig delivered to test.

25 **START GEARBOX AND LUBE SYSTEM RIG ENDURANCE TESTS**
Start initial durability tests of the engine gearbox and lubrication system in the integrated gearbox and lubrication system rig at simulated engine mission cycle conditions. Rig delivered to test.

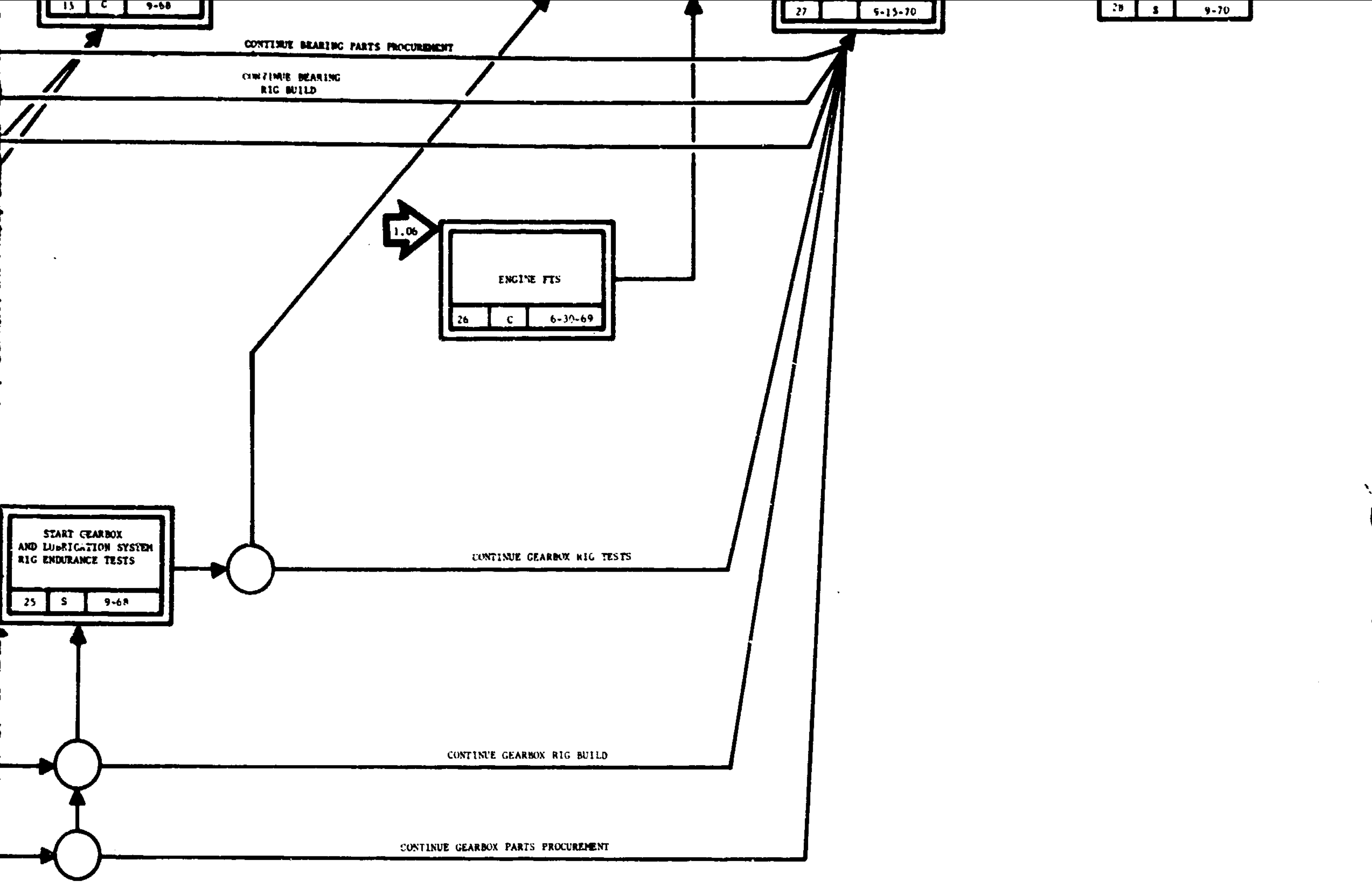
26 **ENGINE FTS**
Reference engine network 1.06 for description and criteria.

27 **COMPLETE SUSTAINING ENGINEERING FOR 100 HOUR FLIGHT TEST**
Completion of engineering effort necessary to support first 100 hours of flight test. Completion of 100 hours of flight test.

28 **CONTINUE BEARING, SEALS, AND GEARBOX DEVELOPMENT**
Start Phase IV bearing, seal, and gearbox development in a program continuous from Phase III. Phase IV go-ahead received from FAA.

[illegible] **SELECT CERTIFICATION CONFIGURATION**
Select design of bearings, seals, [illegible] to be used in engine certification [illegible] pletion of design drawings of bea[illegible] and gearboxes to be used in engine [illegible] tests.

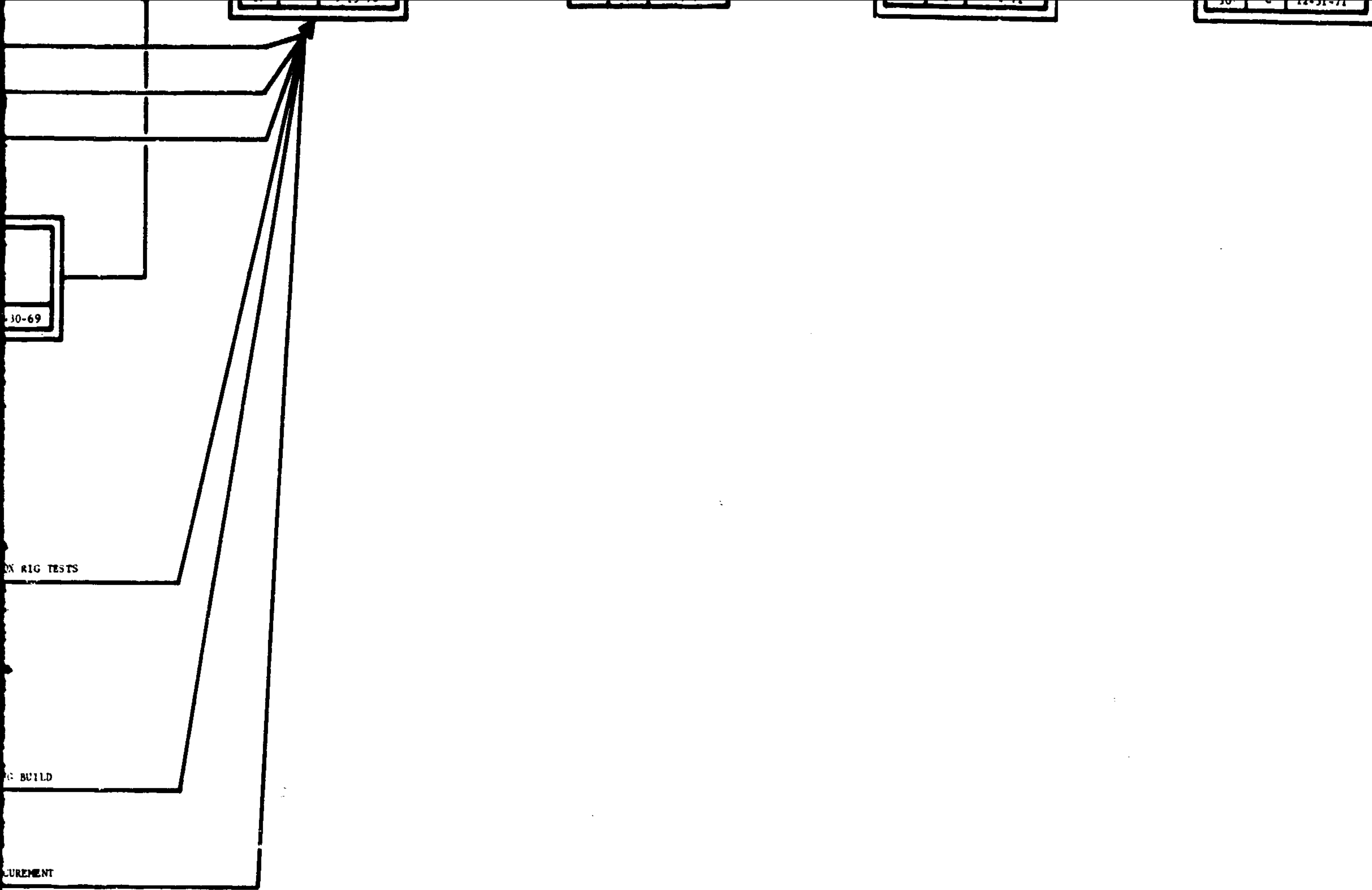
[illegible] **ENGINE CERTIFICATION**
Reference engine network 1.06 for [illegible] and criteria.



Description and Criteria

SELECT CERTIFICATION CONFIGURATION
Select design of bearings, seals, and gearboxes to be used in engine certification test. Completion of design drawings of bearings, seals, and gearboxes to be used in engine certification tests.

ENGINE CERTIFICATION
Reference engine network 1.06 for description and criteria.



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1.18 FUELS

The fuel development program will continue to be directed toward the evaluation of the fuel specifications for the JTF17 engine. Commercial aviation kerosene will be used and testing will be accomplished to determine the adequacy of this fuel. Coordination will continue with the airframe contractor, airlines and oil companies to ensure the acceptability of the fuel specifications.

Testing will be conducted at simulated operating conditions in the JTF17 engine and primary combustor rigs to determine the acceptability of the thermal stability characteristics of the fuel at typical engine system heat rejection levels. This testing will also determine the effect of the fuel luminosity on the combustor and turbine sections of the engine. Materials erosion and corrosion tests will be combined with the turbine development program to determine the materials and coatings necessary for long periods of operation. These tests will provide guidance for acceptable fuel sulfur limits.

Lubricity test methods will continue to be investigated using fuel at temperatures to be encountered in the engine system. These tests will be correlated with component experience to define the lubricity of commercial aviation kerosene.

The major milestones, network chart and event dictionary for the fuels program are shown in figures 35 and 36, respectively.

A detailed description of the fuels program is presented in the Test and Certification Plan, Volume III, Report E. Test planning and integration is presented in Test, Volume IV, Report E.

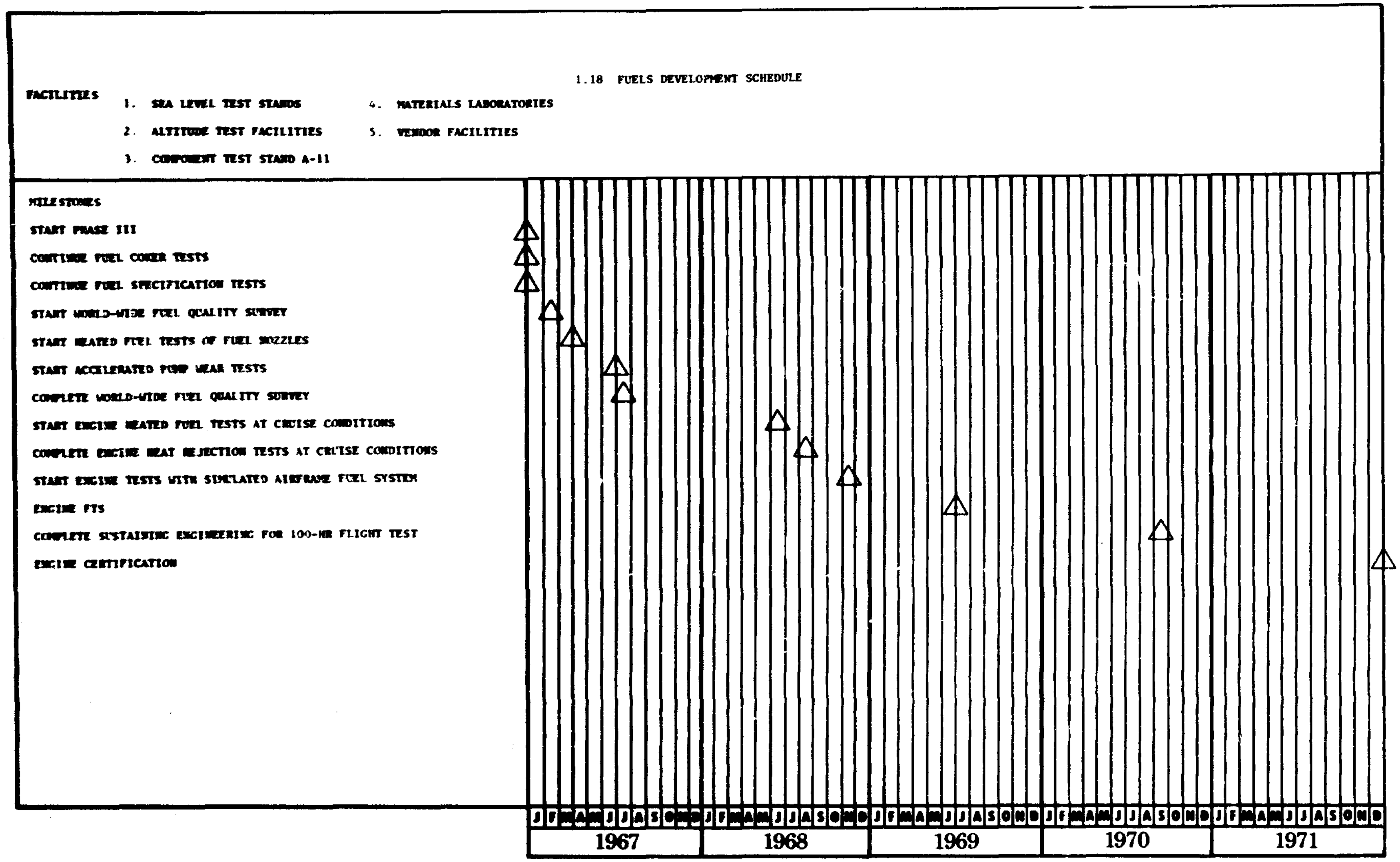

Figure 35. 1.18 Fuels

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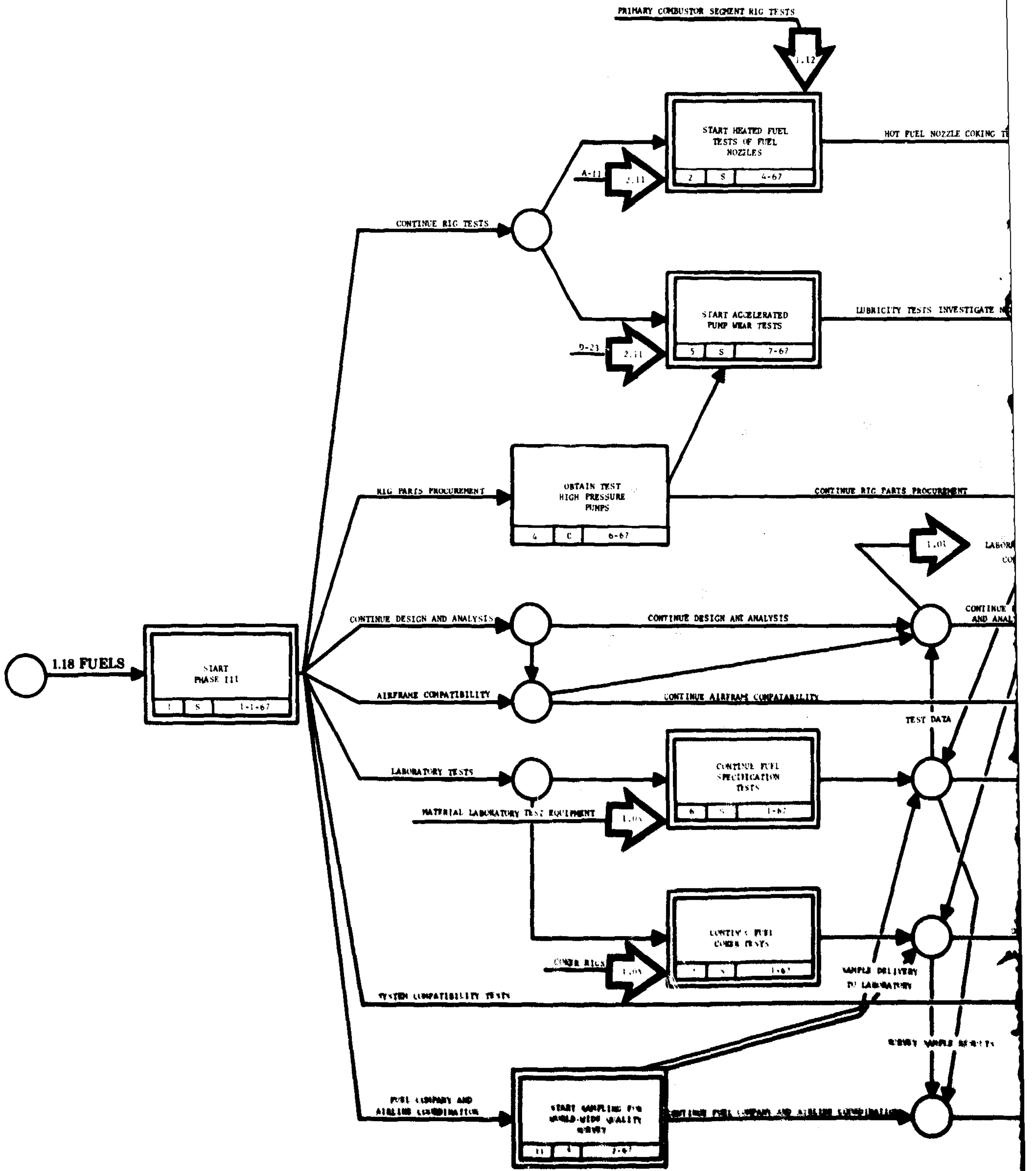
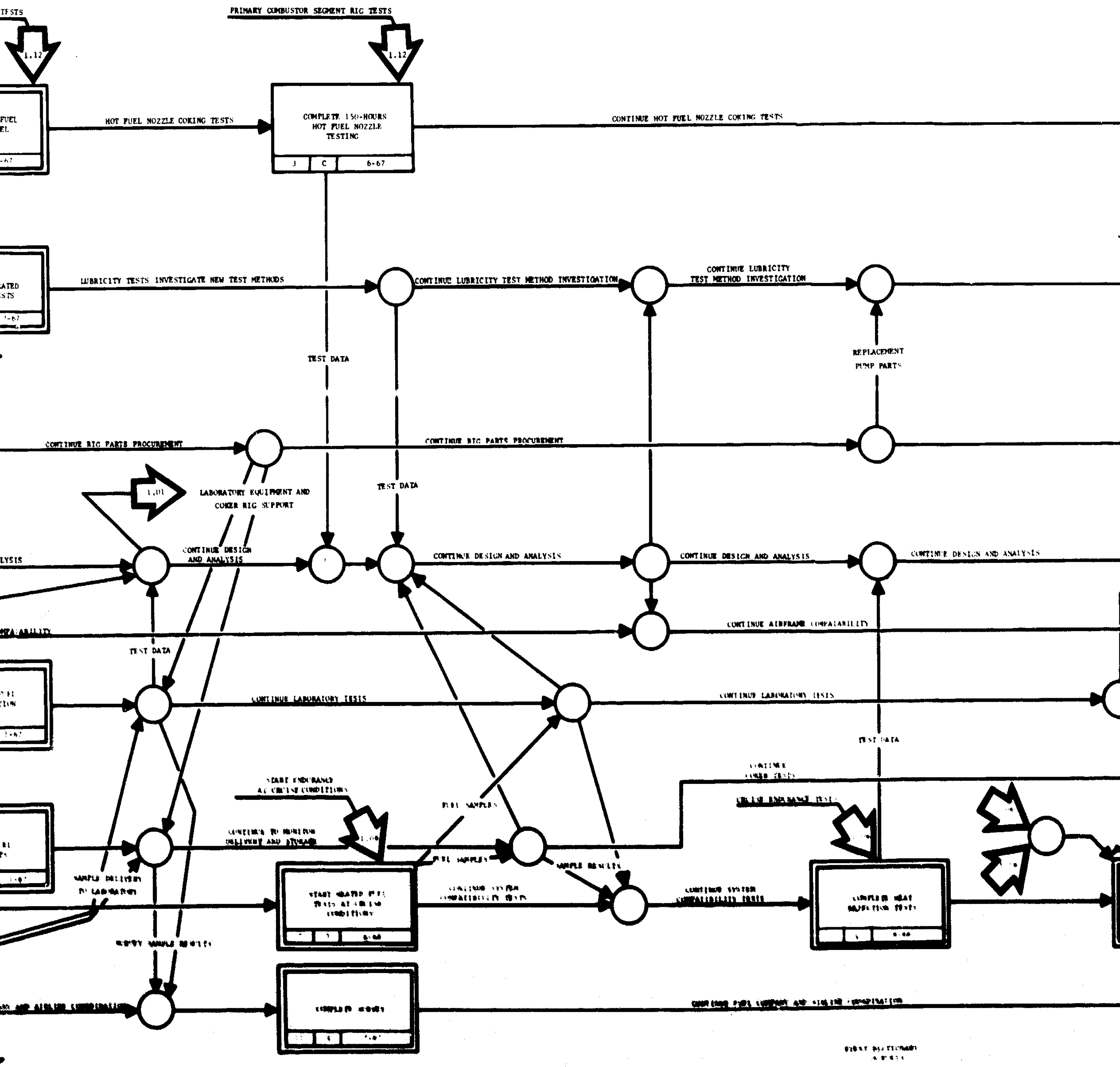


Figure 36. 1.18 Fuels

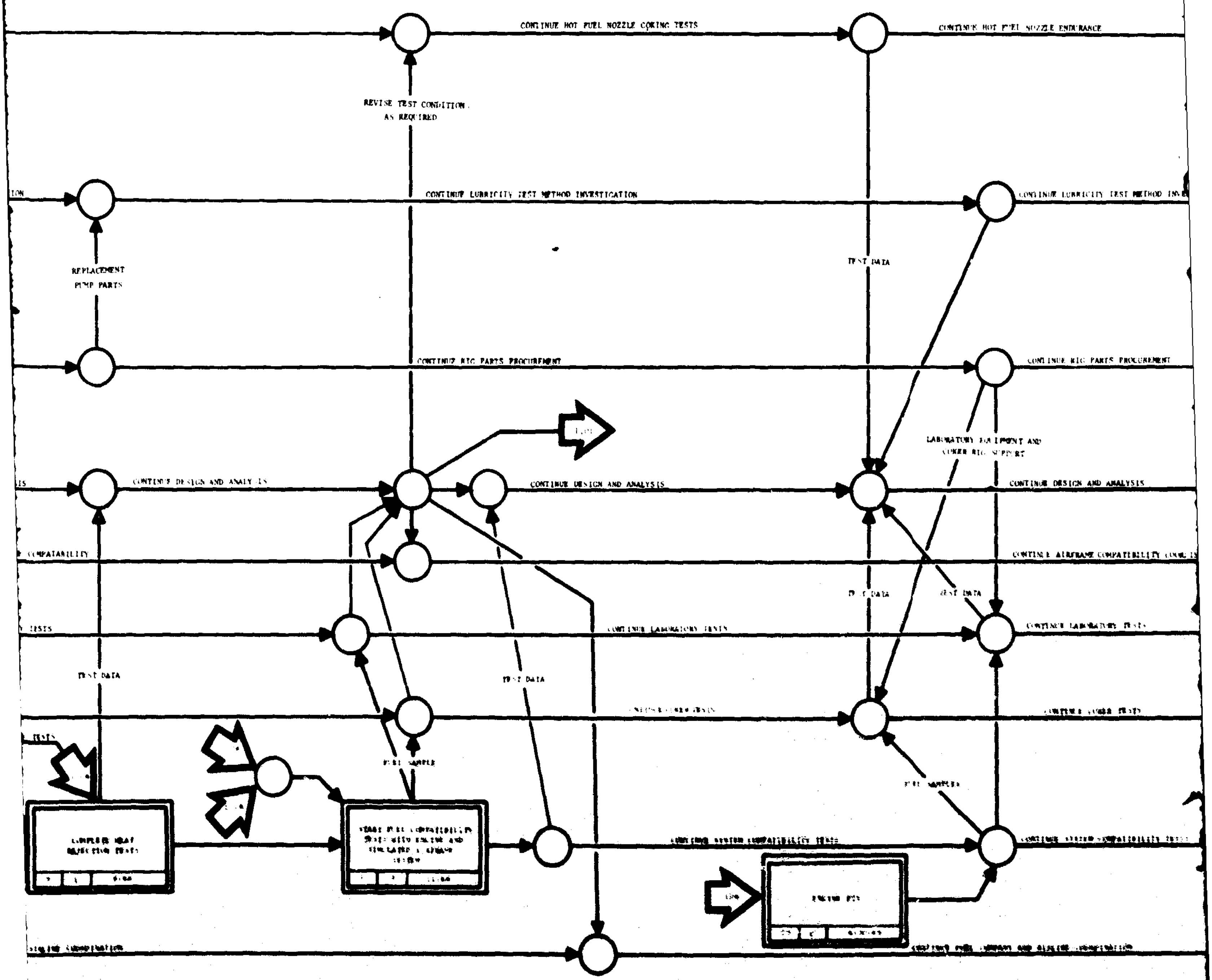
1.18 Fuels

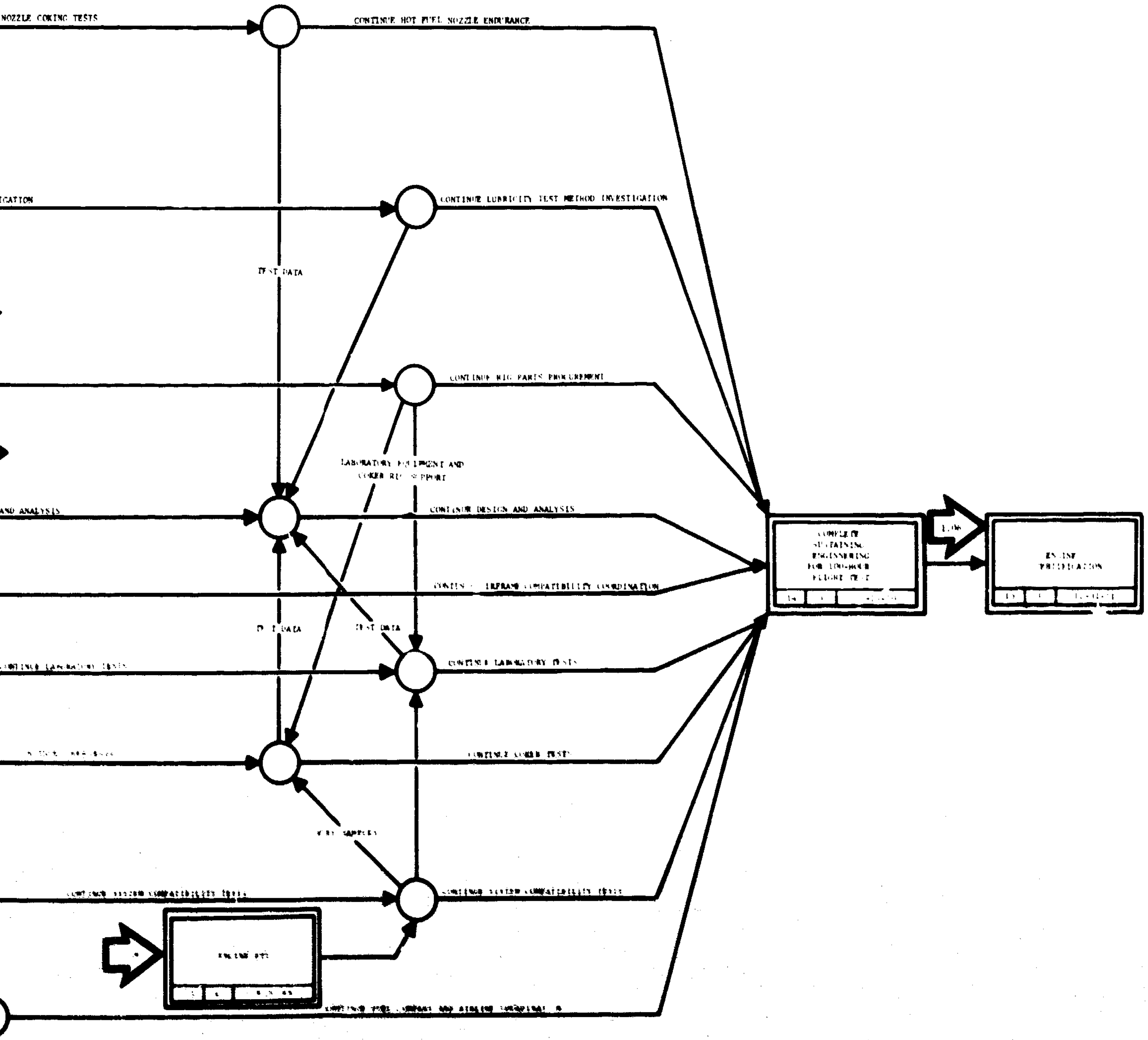


PRIMARY COMBUSTOR SEGMENT RIG TESTS
1.12
HOT FUEL NOZZLE COKING TESTS
COMPLETE 150-HOURS HOT FUEL NOZZLE TESTING
6-67
CONTINUE HOT FUEL NOZZLE COKING TESTS
LUBRICITY TESTS INVESTIGATE NEW TEST METHODS
CONTINUE LUBRICITY TEST METHOD INVESTIGATION
CONTINUE LUBRICITY TEST METHOD INVESTIGATION
TEST DATA
REPLACEMENT PUMP PARTS
CONTINUE RIG PARTS PROCUREMENT
CONTINUE RIG PARTS PROCUREMENT
LABORATORY EQUIPMENT AND COKER RIG SUPPORT
TEST DATA
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
CONTINUE AIRFRAME COMPATABILITY
TEST DATA
CONTINUE LABORATORY TESTS
CONTINUE LABORATORY TESTS
TEST DATA
START ENDURANCE AT CRUISE CONDITIONS
FUEL SAMPLES
FUEL SAMPLES
SAMPLE RESULTS
SAMPLE DELIVERY TO LABORATORY
CONTINUE SYSTEM COMPATIBILITY TESTS

2

1.18 Fuels


CONTINUE HOT FUEL NOZZLE COKING TESTS
REVISE TEST CONDITION
AS REQUIRED
CONTINUE LUBRICITY TEST METHOD INVESTIGATION
REPLACEMENT
PUMP PARTS
CONTINUE RIG PARTS PROCUREMENT
TEST DATA
CONTINUE DESIGN AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
LABORATORY EQUIPMENT AND
COKER RIG SUPPORT
CONTINUE DESIGN AND ANALYSIS
TEST DATA
TEST DATA
CONTINUE LABORATORY TESTS
TEST DATA
TEST DATA
FUEL SAMPLE
FUEL SAMPLES


NOZZLE COKING TESTS
CONTINUE HOT FUEL NOZZLE ENDURANCE
CONTINUE LUBRICITY TEST METHOD INVESTIGATION
TEST DATA
CONTINUE RIG PARTS PROCUREMENT
LABORATORY EQUIPMENT AND
COKER RIG SUPPORT
AND ANALYSIS
CONTINUE DESIGN AND ANALYSIS
TEST DATA
CONTINUE LABORATORY TESTS
CONTINUE COKER TESTS
CONTINUE SYSTEM COMPATIBILITY TESTS
COMPLETE
SUSTAINING
ENGINEERING
FOR 100-HOUR
FLIGHT TEST

1.19 MANUFACTURING TECHNIQUES AND MATERIALS

Long and short time mechanical property evaluation on materials specified for the JTF17 engine will be completed by the end of Phase II-C. During Phase III major effort will include upgrading the mechanical properties of engine hardware components through the development of improved metallurgical processing used by our suppliers of raw material and finished parts and by our Manufacturing shops.

The Materials Development Laboratories will provide support to the manufacturing shops in the development of metallurgical processing, and work directly with the suppliers of major finished parts in solving manufacturing problems and developing improved processing techniques.

Once improved processes have been established, process controls will be instituted at each step so that the highest order of reproducibility of the final product will be attained for engine reliability. Such reproducibility of manufacture also results in lower product cost due to reduced rework operations and lowered scrap rates.

The Material Control Laboratories together with the Vendor Quality Control group will ensure that established process controls used by suppliers are followed on major parts through resident personnel stationed at the supplier's manufacturing facilities.

Metallurgical investigation and analysis of engine failures during development of the JTF17 engine will be performed to provide basic information for the improvement of materials leading to desired component integrity and reliability.

Major activity will also include the effort to develop new materials and processing of hardware components to meet the engine performance objectives and provide engine growth potential. Specifically, development will be directed toward materials which will afford weight saving, extended service life, and increased operating temperature capability. Strong emphasis will be placed concurrently on analysis of material characteristics which affect producibility of hardware in consideration of the economics of production.

Advanced materials and processing technology acquired on the J58 engine program will be applied to the development of advanced engine hardware for the JTF17. This work has been discussed in Manufacturing Techniques and Materials, Volume III, Report F.

The major milestones, network chart and event dictionary for manufacturing techniques and materials are shown in figures 37 and 38, respectively.

Test planning and integration is presented in Test, Volume IV, Report E.

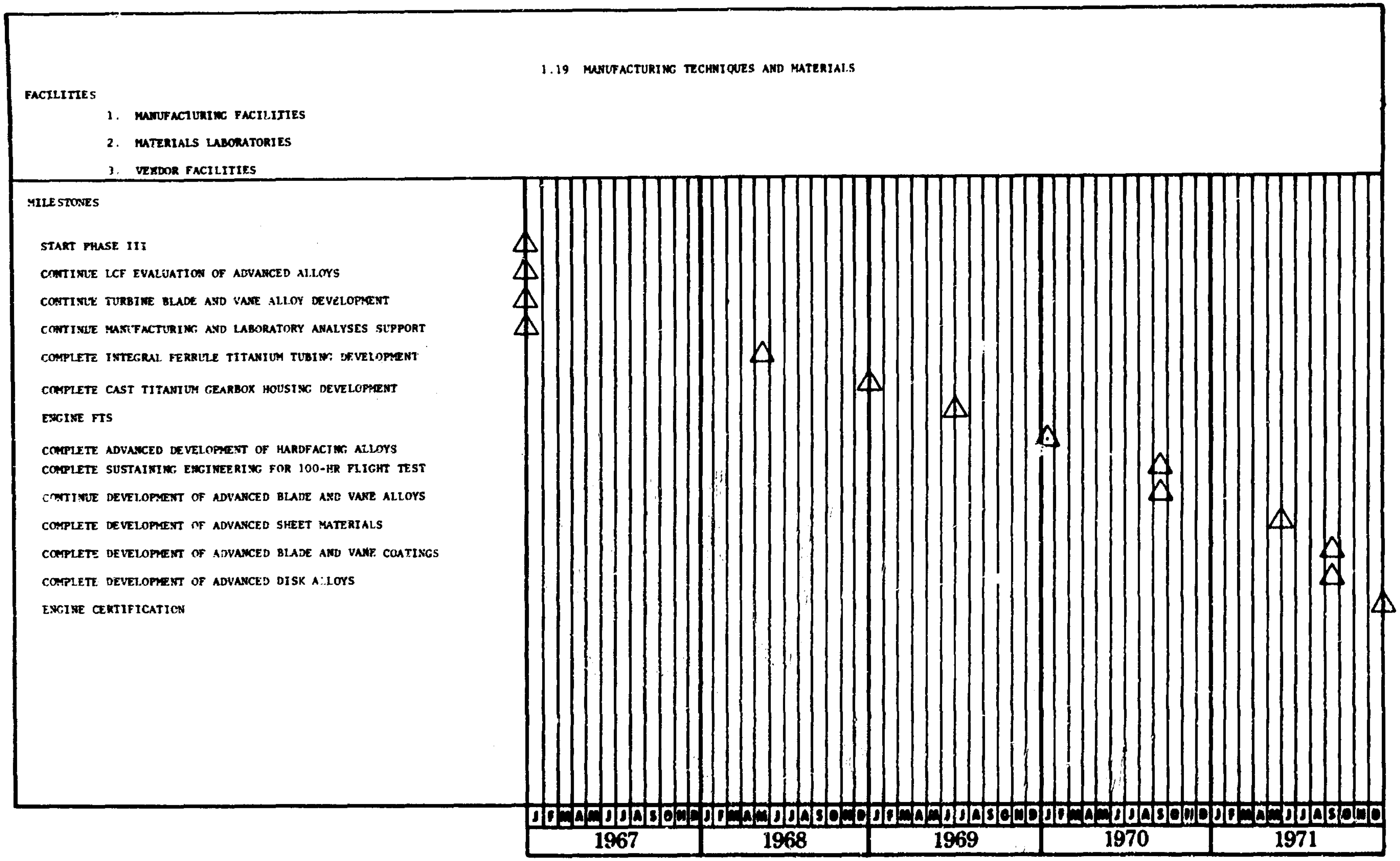


Figure 37. 1.19 Manufacturing Techniques and Materials

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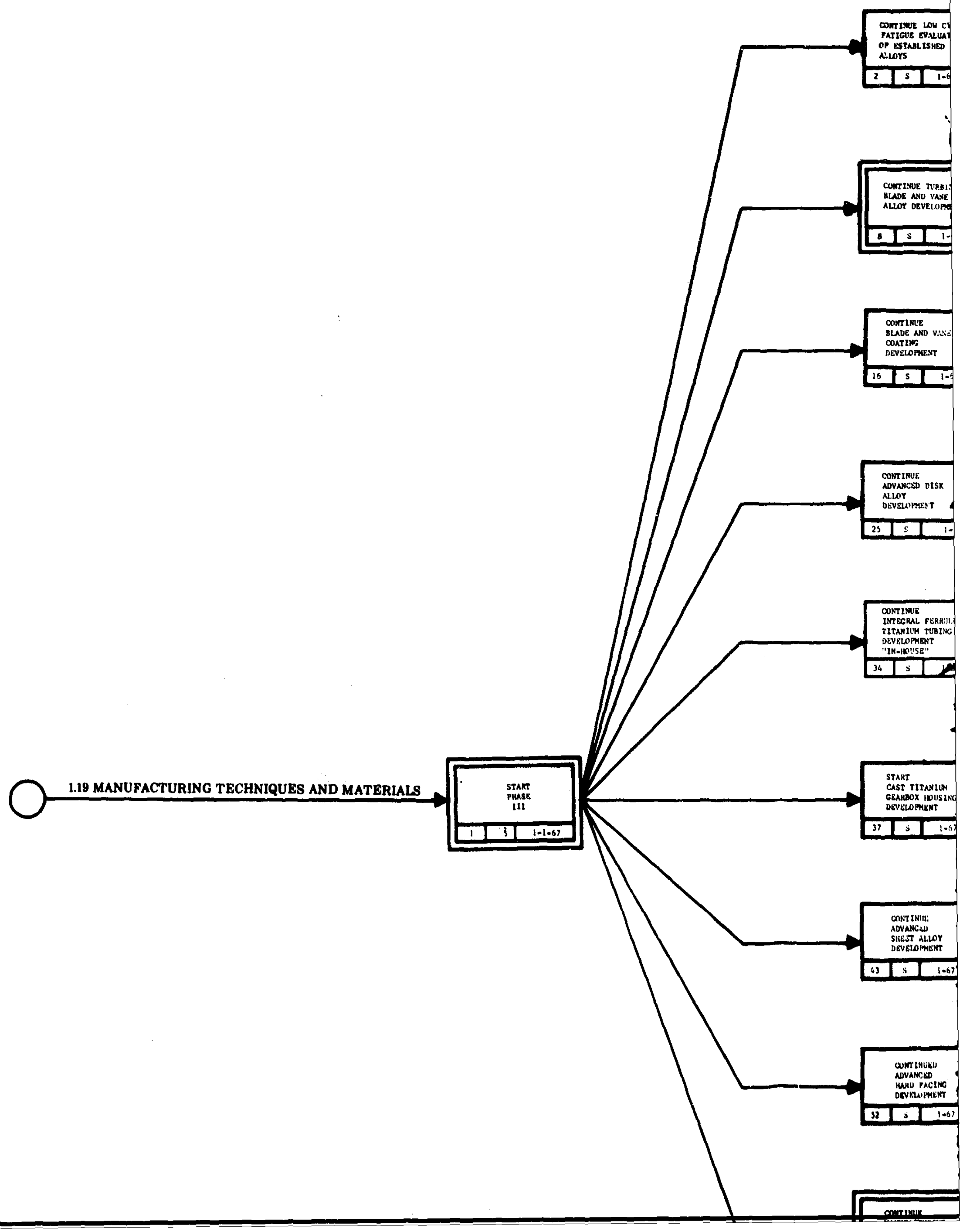
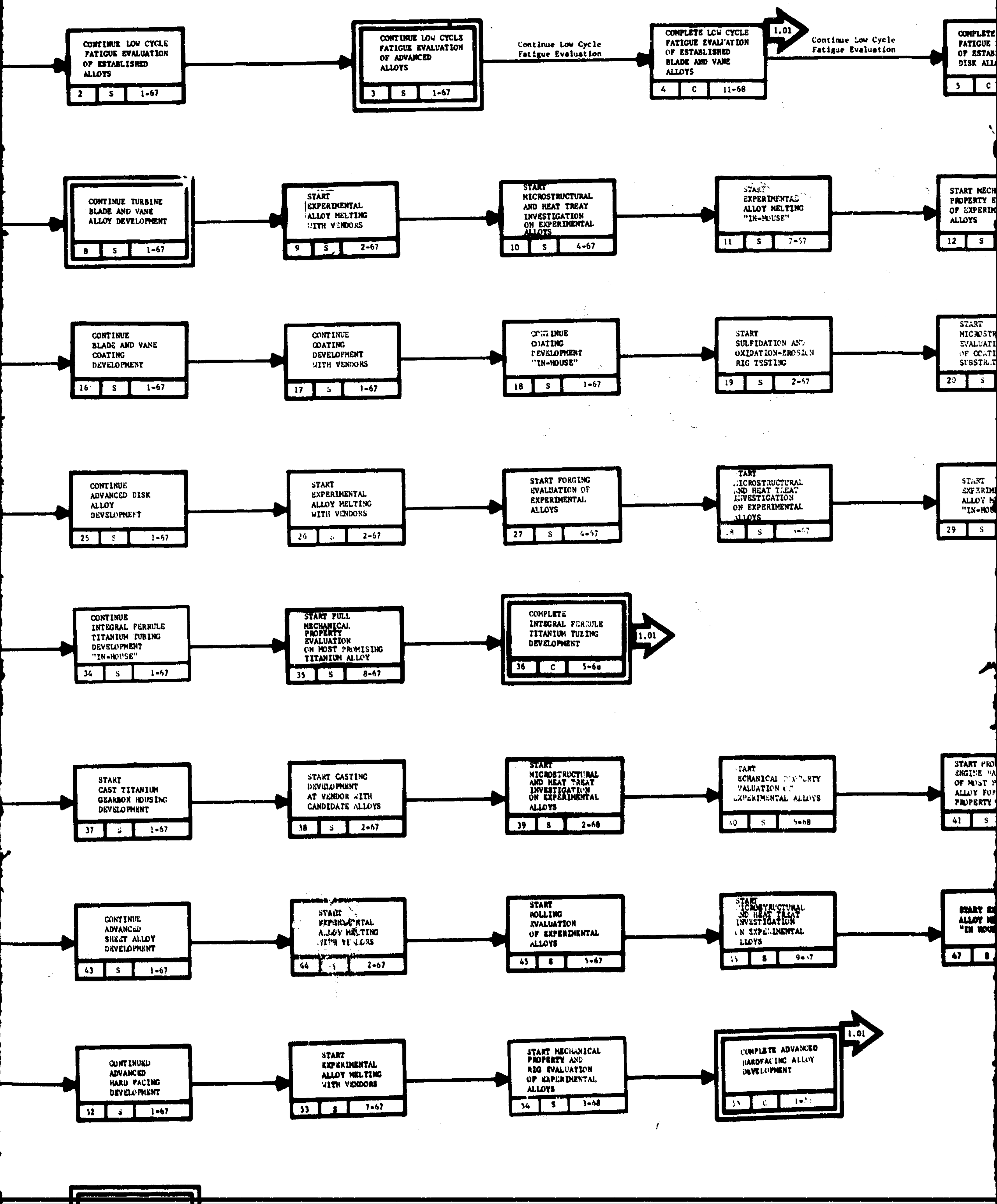


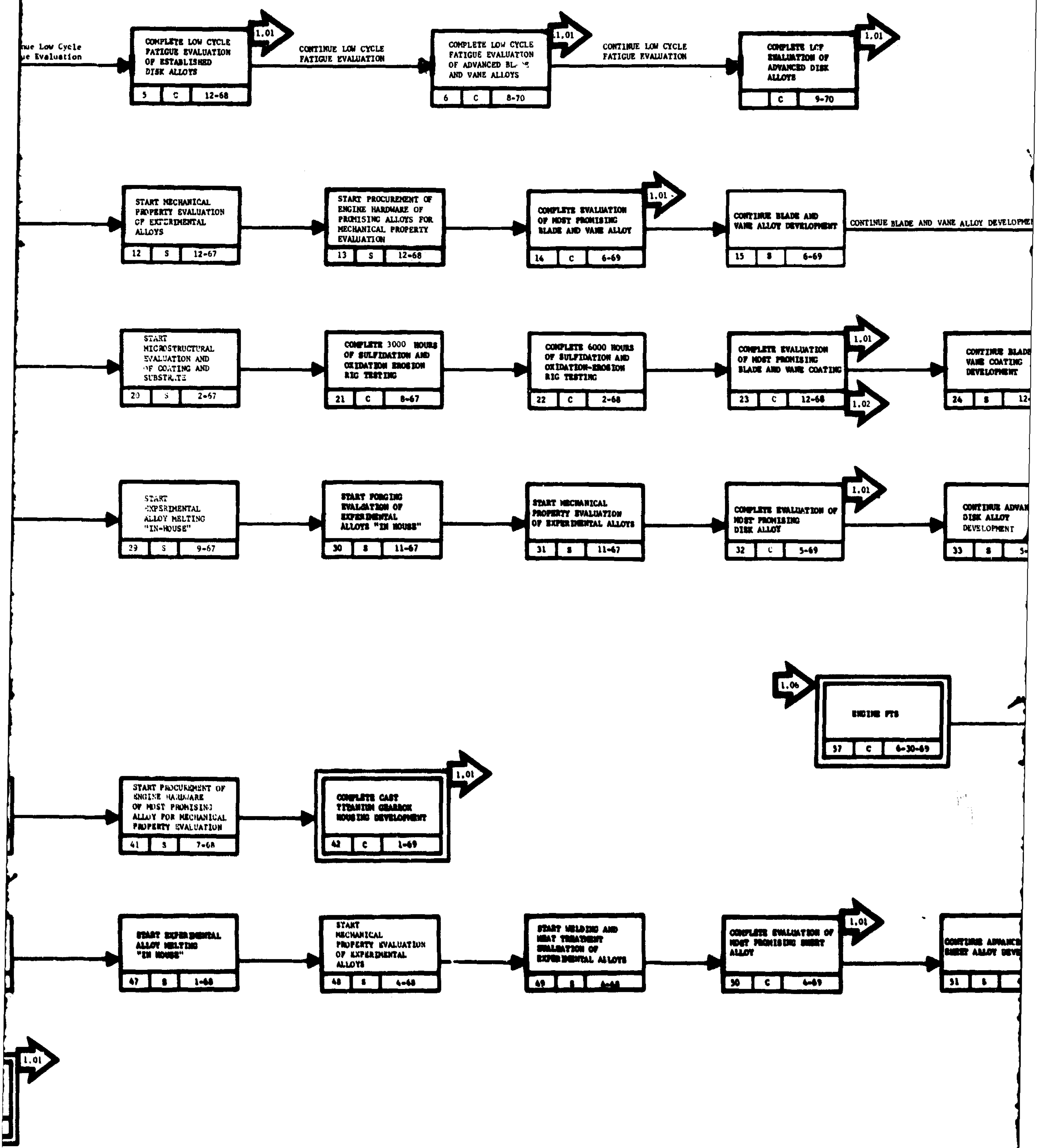
1.19 MANUFACTURING TECHNIQUES AND MATERIALS
START PHASE III
1 3 1-1-67
CONTINUE LOW CY
FATIGUE EVALUAT
OF ESTABLISHED
ALLOYS
2 S
CONTINUE TURBI
BLADE AND VANE
ALLOY DEVELOPME
8 S
CONTINUE
BLADE AND VANE
COATING
DEVELOPMENT
16 S
CONTINUE
ADVANCED DISK
ALLOY
DEVELOPMENT
25 S
CONTINUE
INTEGRAL FERRUL
TITANIUM TUBING
DEVELOPMENT
"IN-HOUSE"
34 S
START
CAST TITANIUM
GEARBOX HOUSING
DEVELOPMENT
37 S 1-67
CONTINUE
ADVANCED
SHEET ALLOY
DEVELOPMENT
43 S 1-67
CONTINUED
ADVANCED
HARD FACING
DEVELOPMENT
52 S 1-67
CONTINUE

12

1.19 Manufactur



9 Manufacturing Techniques and Materials



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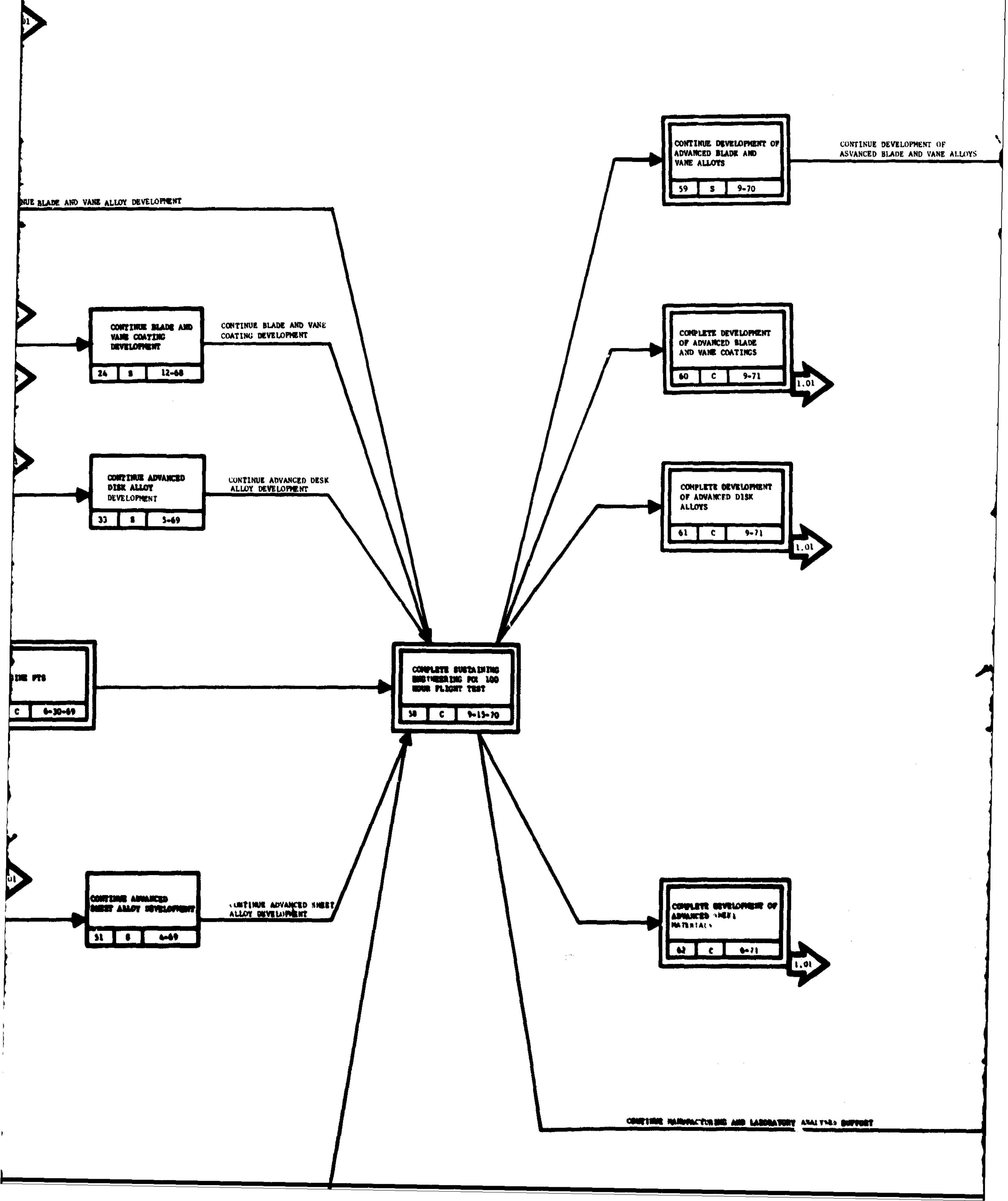
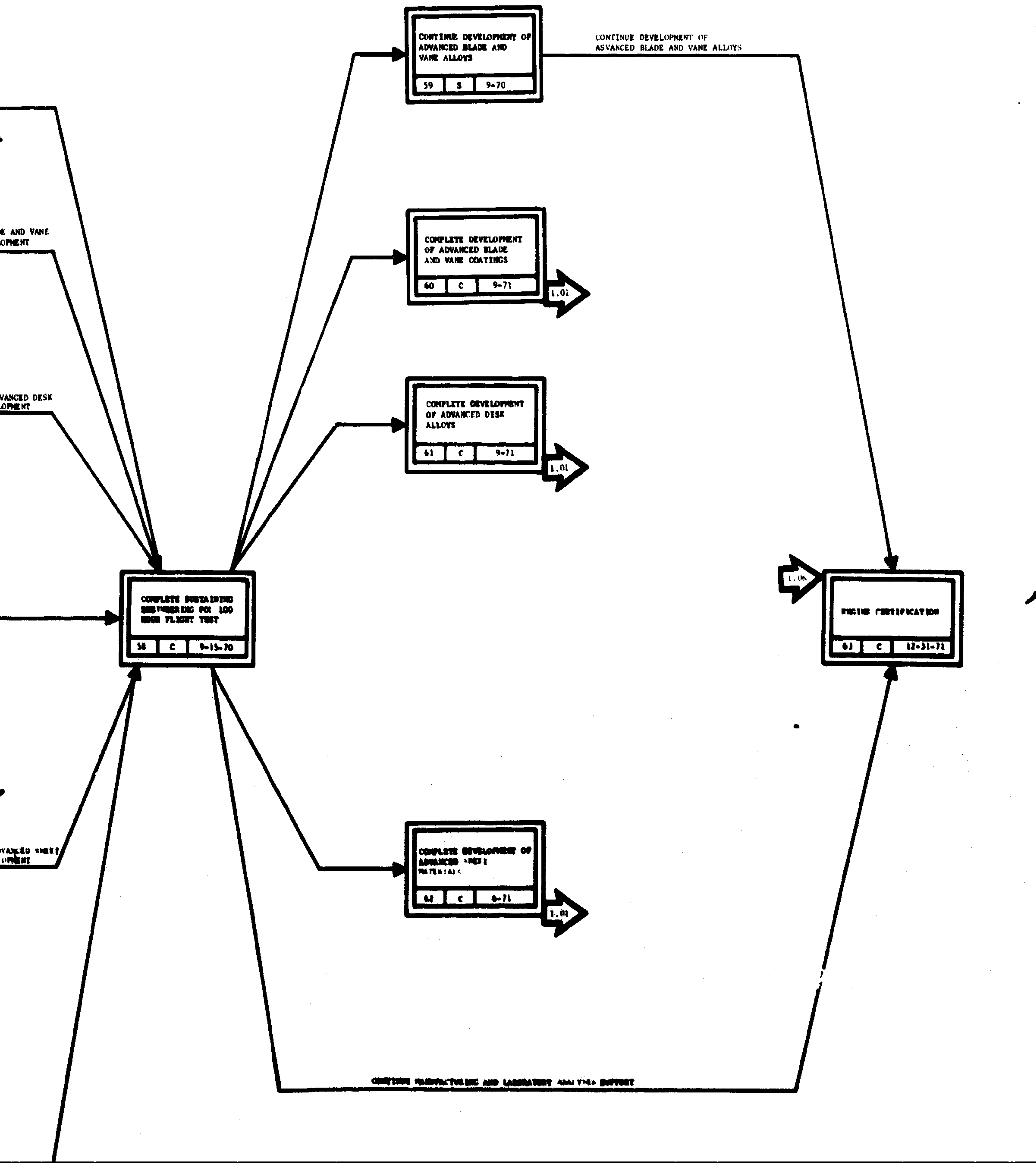
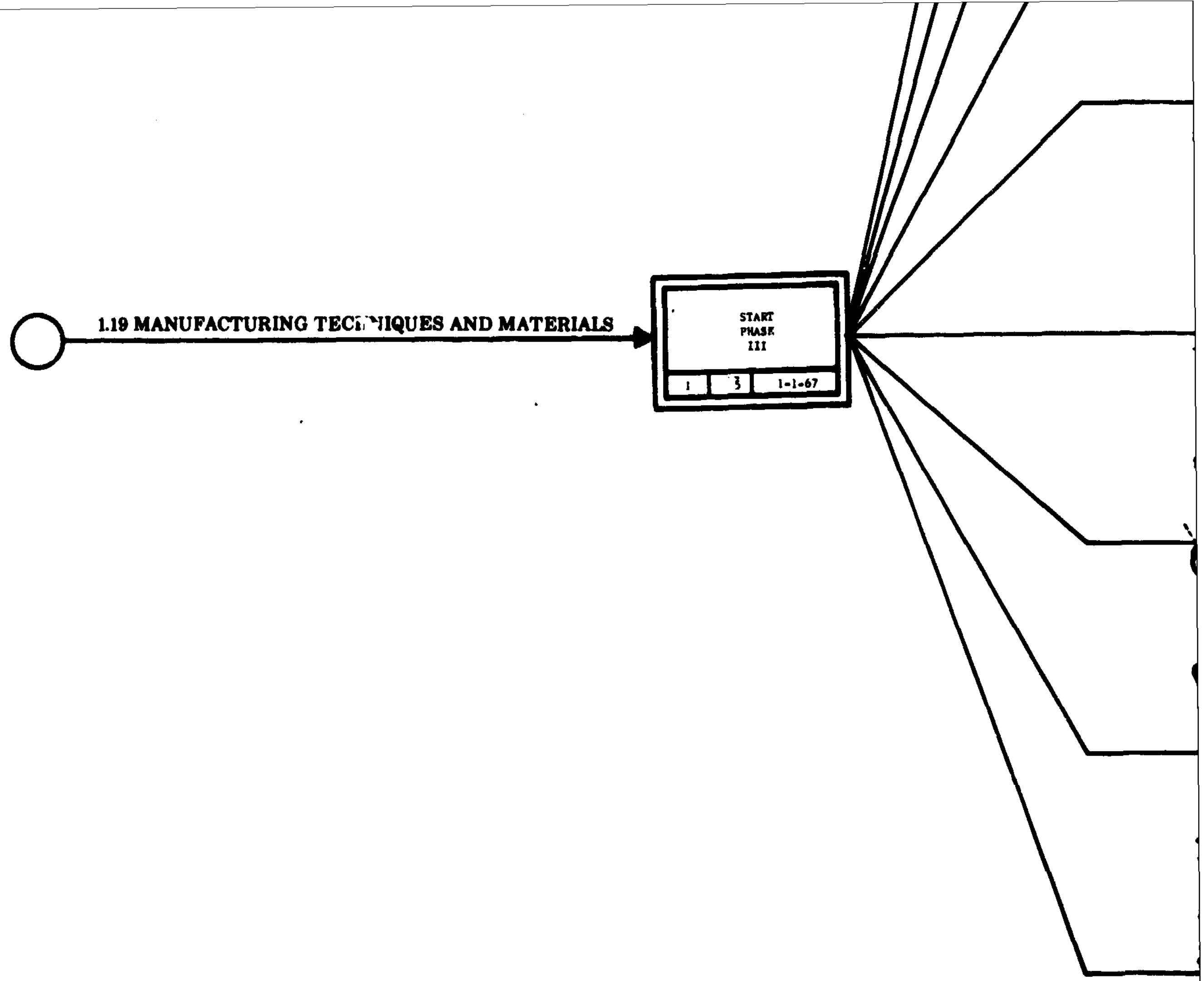


CONTINUE DEVELOPMENT OF ADVANCED BLADE AND VANE ALLOYS
59 S 9-70
CONTINUE DEVELOPMENT OF ASVANCED BLADE AND VANE ALLOYS
...UE BLADE AND VANE ALLOY DEVELOPMENT
CONTINUE BLADE AND VANE COATING DEVELOPMENT
24 S 12-68
CONTINUE BLADE AND VANE COATING DEVELOPMENT
COMPLETE DEVELOPMENT OF ADVANCED BLADE AND VANE COATINGS
60 C 9-71
1.01
CONTINUE ADVANCED DISK ALLOY DEVELOPMENT
33 S 5-69
CONTINUE ADVANCED DESK ALLOY DEVELOPMENT
COMPLETE DEVELOPMENT OF ADVANCED DISK ALLOYS
61 C 9-71
1.01
C 6-30-69
COMPLETE SUSTAINING ENGINEERING FOR 100 HOUR FLIGHT TEST
58 C 9-15-70
CONTINUE ADVANCED SHEET ALLOY DEVELOPMENT
31 S 6-69
CONTINUE ADVANCED SHEET ALLOY DEVELOPMENT
62 C 6-71
1.01

5


CONTINUE DEVELOPMENT OF ADVANCED BLADE AND VANE ALLOYS
59 S 9-70
CONTINUE DEVELOPMENT OF ASVANCED BLADE AND VANE ALLOYS
COMPLETE DEVELOPMENT OF ADVANCED BLADE AND VANE COATINGS
60 C 9-71
1.01
COMPLETE DEVELOPMENT OF ADVANCED DISK ALLOYS
61 C 9-71
1.01
E AND VANE
OPMENT
VANCED DESK
LOPMENT



Event Number	Description and Criteria
[illegible]	**START PHASE III** Commence Phase III Materials Development Program. Phase III go-ahead.
[illegible]	**CONTINUE LCF EVALUATION OF ESTABLISHED ALLOYS** Continue laboratory LCF evaluation of established alloys for JTF17 engine. Laboratory evaluation in progress.
[illegible]	**CONTINUE LCF EVALUATION OF ADVANCED ALLOYS** Continue laboratory LCF evaluation of advanced alloys for JTF17 engine. Laboratory evaluation in progress.
[illegible]	**COMPLETE LCF EVALUATION OF ESTABLISHED BLADE AND VANE ALLOYS** Conduct comparative LCF evaluation of established JTF17 blade and vane alloys based on test results and microstructural examination. Release results to Design Engineering.
[illegible]	**COMPLETE LCF EVALUATION OF ESTABLISHED DISK ALLOYS** Conduct comparative LCF evaluation of established JTF17 disk alloys based upon mechanical test results and microstructural examination. Release results to Design Engineering.
[illegible]	**COMPLETE LCF EVALUATION OF ADVANCED BLADE AND VANE ALLOYS** Conduct comparative LCF evaluation of advanced blade and vane alloys based upon mechanical test results and microstructural examination. Release results to Design Engineering.
[illegible]	**COMPLETE LCF EVALUATION OF ADVANCED DISK ALLOYS** Conduct comparative LCF evaluation of advanced disk alloys based upon mechanical test results and microstructural examination. Release results to Design Engineering.
[illegible]	**CONTINUE TURBINE BLADE AND VANE ALLOY DEVELOPMENT** Continue alloy development programs aimed at improved creep strength, oxidation and sulfidation resistance for JTF17. Mechanical and physical property evaluation in progress.
[illegible]	**START EXPERIMENTAL ALLOY MELTING WITH VENDORS** Start melting of experimental [illegible] aimed at improved blade and vane alloy capability. Place orders for procurement.
10	**START MICROSTRUCTURAL AND HEAT TREAT INVESTIGATION ON EXPERIMENTAL ALLOYS** Start heat treating and [illegible] of candidate alloys [illegible] laboratory heat treat equipment and electron [illegible] investigation.
11	**START EXPERIMENTAL ALLOY MELTING [illegible]** Start melting of experimental [illegible] the lab [illegible] aimed at improved [illegible] alloy capability. [illegible]
12	**START MECHANICAL PROPERTY EVALUATION OF EXPERIMENTAL ALLOYS** Start tensile, creep rupture and [illegible] tests at selected test temperatures [illegible] potential blade and vane alloys [illegible] tion programs.
[illegible]	**START PROCUREMENT OF ENGINE HARDWARE OF PROMISING ALLOYS FOR MECHANICAL PROPERTY EVALUATION** Start procurement of experimental [illegible] vane configurations of selected alloys. Place orders for procurement with qualified vendors.
14	**COMPLETE EVALUATION OF MOST PROMISING BLADE AND VANE ALLOY** Conduct complete mechanical and physical property evaluation of most promising blade and vane alloy. Release results and recommendations to Design and Experimental Engineering.
15	**CONTINUE BLADE AND VANE ALLOY DEVELOPMENT** Continue mechanical and physical property and microstructural evaluation of materials with improved capability for JTF17 blade and vane application. Mechanical and physical property evaluation in progress.
16	**CONTINUE BLADE AND VANE COATING DEVELOPMENT** Continue laboratory oxidation, erosion and [illegible] tion testing of candidate blade and vane coatings for JTF17 engine. Laboratory evaluation in progress.

Figure 38. 1.19 Manufacturing Techniques and Materials

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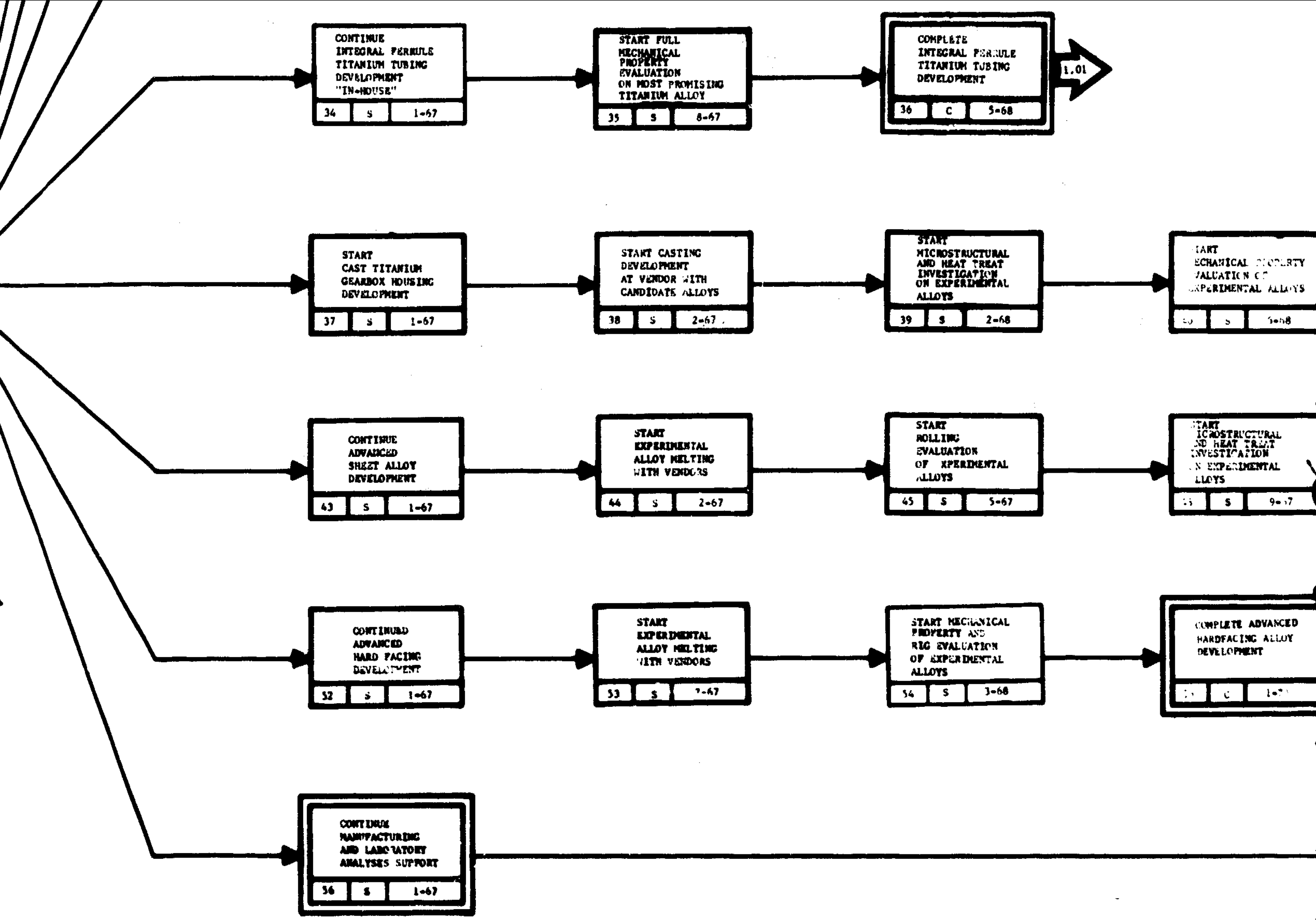
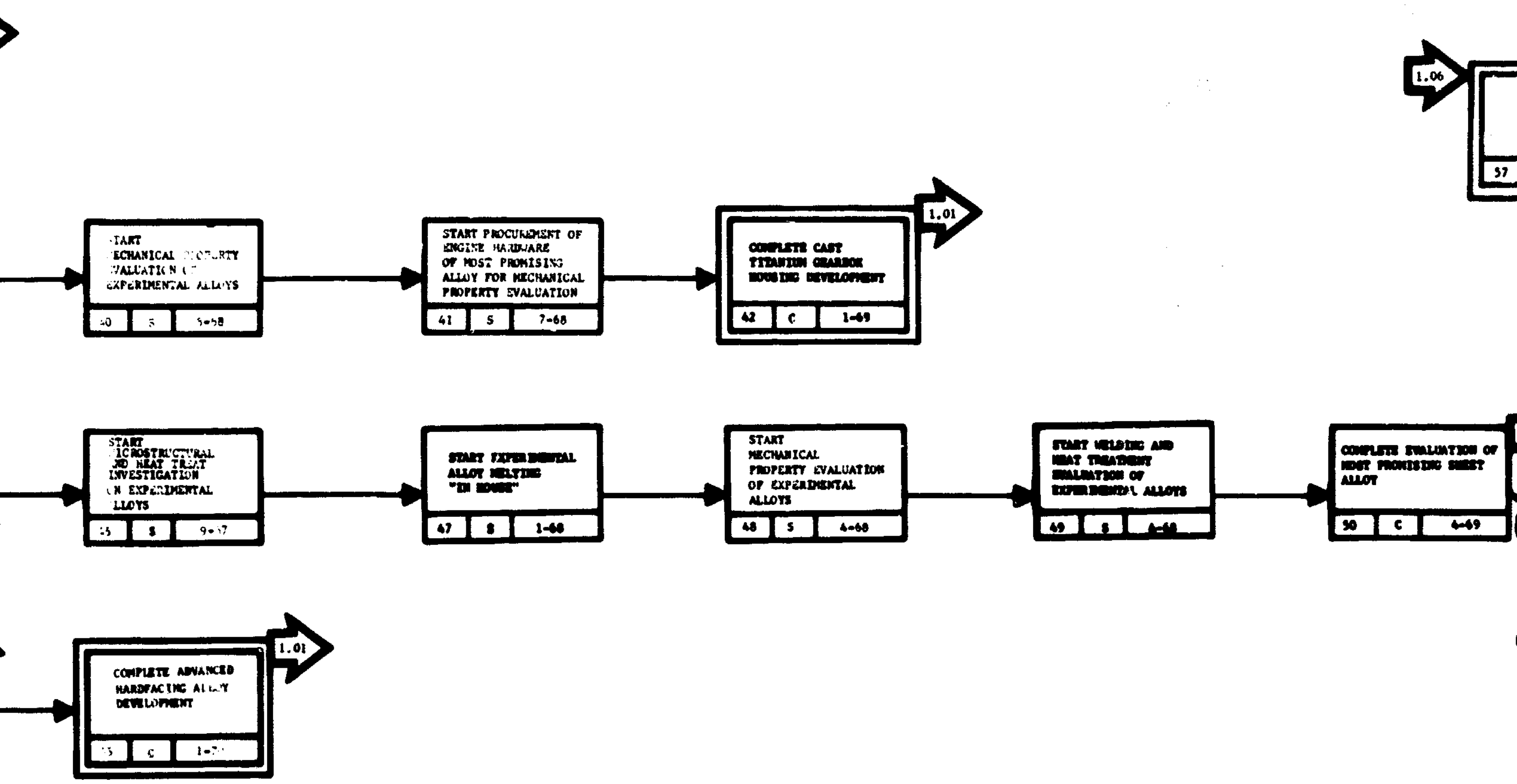


Description and Criteria	Event Number	Description and Criteria	Event Number	Description and Criteria
[illegible]	[illegible]	CONTINUE COATING DEVELOPMENT WITH VENDORS [illegible]	[illegible]	CONTINUE ADVANCED DISK ALLOY DEVELOPMENT [illegible]
[illegible]	[illegible]	CONTINUE COATING DEVELOPMENT "IN-HOUSE" [illegible]	[illegible]	START EXPERIMENTAL ALLOY MELTING WITH VENDORS [illegible]
[illegible]	[illegible]	START SULFIDATION AND OXIDATION EROSION RIG TESTING [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	COMPLETE EVALUATION OF MOST PROMISING BLADE AND VANE COATING [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	CONTINUE BLADE AND VANE COATING DEVELOPMENT [illegible]		

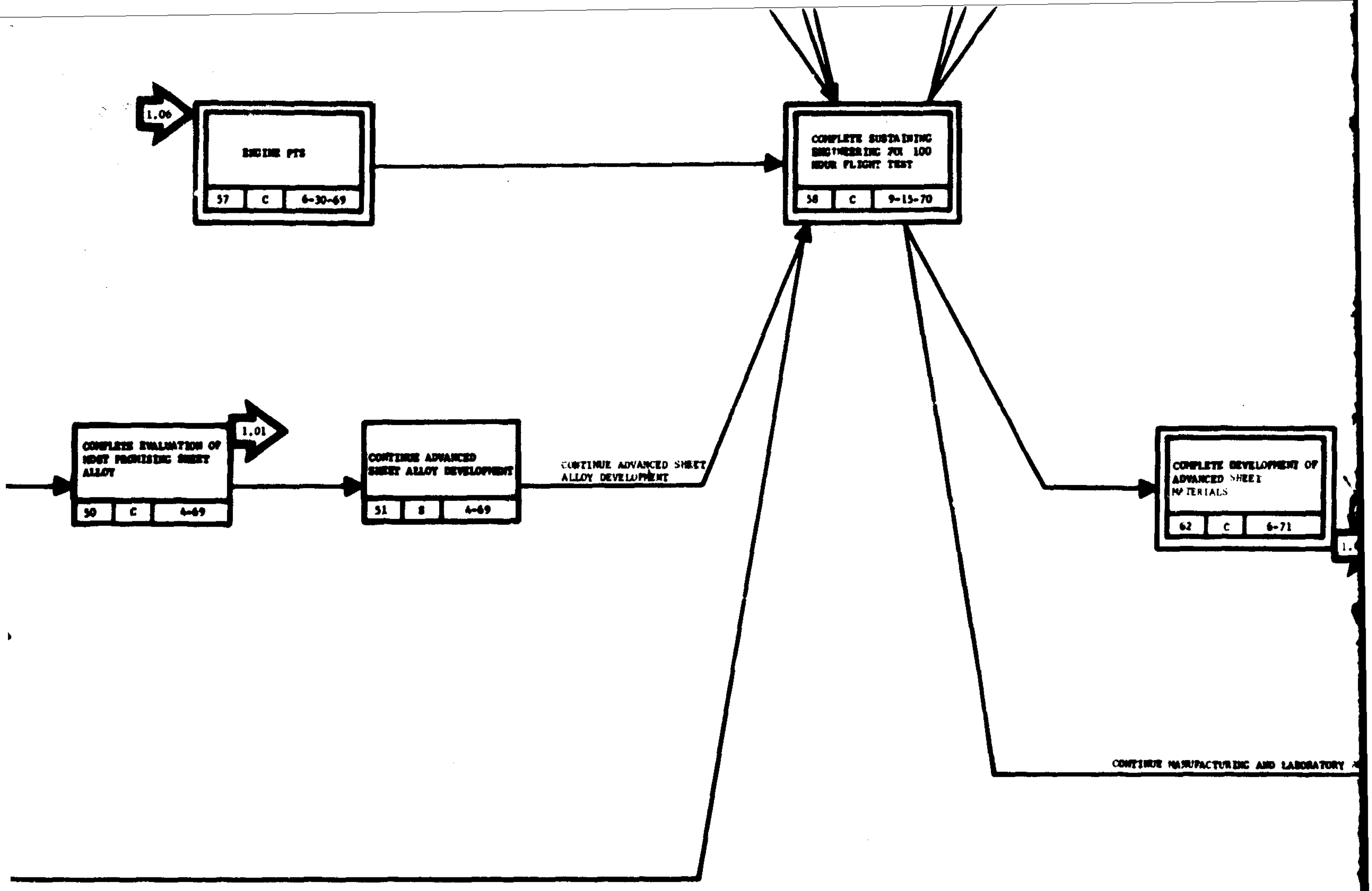
7



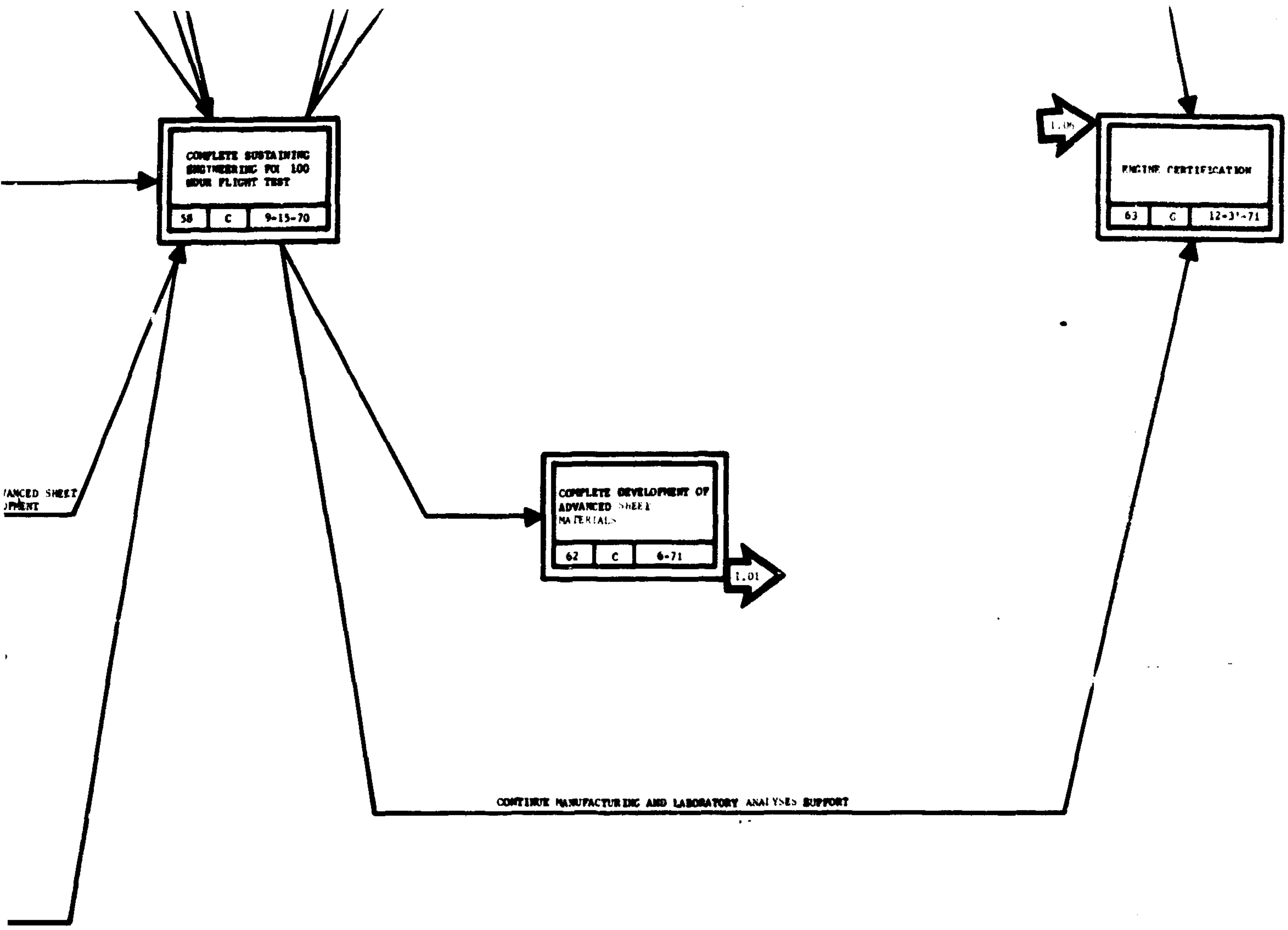
CONTINUE MANUFACTURING AND LABORATORY ANALYSES SUPPORT

EVENT DICTIONARY
1.19 MANUFACTURING TECHNIQUES AND MATERIALS

Event Number	Description and Criteria
[illegible]	[illegible] ADVANCED DISK ALLOY DEVELOPMENT [illegible]
[illegible]	[illegible] EXPERIMENTAL ALLOY MELTING WITH VENDORS [illegible]
[illegible]	[illegible] EXPERIMENTAL ALLOYS [illegible]
[illegible]	[illegible] HEAT TREAT INVESTIGATION [illegible]
[illegible]	[illegible] EXPERIMENTAL ALLOY MELTING "IN HOUSE" [illegible]
[illegible]	[illegible] EVALUATION OF EXPERIMENTAL ALLOYS [illegible]
[illegible]	[illegible] MECHANICAL PROPERTY EVALUATION OF EXPERI[illegible]
[illegible]	[illegible] EVALUATION OF MOST PROMISING DISK ALLOY [illegible] Design and Experimental Engineering.
33	CONTINUE ADVANCED DISK ALLOY DEVELOPMENT Continue chemistry modification program, improving forging practices and mechanical property evaluation of disk alloys with improved capabilities for JTF17 application. Chemistry, forging and mechanical evaluation in progress.
34	CONTINUE INTEGRAL FERRULE TITANIUM TUBING DEVELOPMENT "IN-HOUSE" Continue studies of hot working practices employed in producing sound, high strength integral tubing ferrules with titanium alloys. Laboratory investigation in progress.
35	START FULL MECHANICAL PROPERTY EVALUATION OF MOST PROMISING TITANIUM ALLOY Start tensile fatigue and creep testing of the most promising titanium alloy at selected test temperatures to establish the capability of the alloy. Commence test program.
36	COMPLETE INTEGRAL FERRULE TITANIUM TUBING DEVELOPMENT Complete mechanical property and microstructural evaluation of titanium alloys and the development of improved hot working practices for integral ferrule tubing development. Release results and recommendations to Design and Experimental Engineering.
37	START CAST TITANIUM GEARBOX HOUSING DEVELOPMENT Start studies on casting practices employed in producing sound, high strength titanium gearbox housings. Commence laboratory investigations.
38	START CASTING DEVELOPMENT AT VENDOR WITH CANDIDATE ALLOYS Start melting studies and development of a casting practice that will yield sound, reproducible, complex titanium castings utilizing alloys of interest. Place orders for melting studies with qualified vendors.
39	START MICROSTRUCTURAL AND HEAT TREAT INVESTIGATION OF EXPERIMENTAL ALLOYS Start heat treating and microstructural evaluation of candidate titanium alloys using laboratory heat treating facilities and electron microscope. Commence investigation.
40	START MECHANICAL PROPERTY EVALUATION OF EXPERIMENTAL ALLOYS Start tensile, fatigue, impact and hardness testing at selected test temperatures [illegible] Commence test program.
41	START PROCUREMENT OF ENGINE HARDWARE OF MOST PROMISING ALLOY FOR MECHANICAL PROPERTY EVALUATION [illegible]
42	COMPLETE CAST TITANIUM GEARBOX HOUSING DEVELOPMENT [illegible] Design and Experimental Engineering.
43	CONTINUE ADVANCED SHEET ALLOY DEVELOPMENT [illegible] in progress.
44	START EXPERIMENTAL ALLOY MELTING WITH VENDORS [illegible] Place orders for procurement.
45	START ROLLING EVALUATION OF EXPERIMENTAL ALLOYS [illegible]
46	START MICROSTRUCTURAL AND HEAT TREAT INVESTIGATION OF EXPERIMENTAL ALLOYS [illegible] Commence investigations.
47	START EXPERIMENTAL ALLOY MELTING "IN HOUSE" Start melting of experimental compositions in the laboratory aimed at improved sheet alloy strength capability and fabricability. Commence melting studies.



...tion and Criteria	Event Number	Description and Criteria	Event Number	Description and Criteria
... PROPERTY EVALUATION OF EXPERI... [illegible]	48	START MECHANICAL PROPERTY EVALUATION OF EXPERIMENTAL ALLOYS. Start tensile, creep rupture, fatigue [illegible] tests [illegible] at selected temperatures [illegible] alloys. Complete test program.	55	COMPLETE ADVANCED HARDFACING ALLOY DEVELOPMENT [illegible]
... ENGINE HARDWARE OF MOST ... FOR MECHANICAL PROPERTY [illegible]	49	START WELDING AND HEAT TREATMENT EVALUATION OF EXPERIMENTAL ALLOYS. Start heat treating and [illegible] highly stressed [illegible] establish [illegible] fabricability [illegible]. Complete investigation.	56	CONTINUE MANUFACTURING AND LABORATORY ANALYSIS SUPPORT [illegible]
... [illegible] DEVELOPMENT [illegible]	50	COMPLETE EVALUATION OF MOST PROMISING SHEET ALLOY. Conduct complete mechanical and physical property evaluation of most promising sheet alloy. Release results to Design and Experimental Engineering.	57	ENGINE PTS [illegible]
	51	CONTINUE ADVANCED SHEET ALLOY DEVELOPMENT. Continue [illegible] programs, [illegible] rolling practices and mechanical property evaluation of sheet alloys with higher [illegible] for SST applications. [illegible] rolling and mechanical property evaluation in progress.	58	COMPLETE SUSTAINING ENGINEERING FOR [illegible] FLIGHT TEST [illegible]
... SHEET ALLOY DEVELOPMENT [illegible]	52	CONTINUE ADVANCED HARDFACING DEVELOPMENT. Continue studies on advanced hardfacing alloys with emphasis on hot hardness, coefficient of friction measurement and compatibility with the alloys to which it is to be applied. Laboratory studies in progress.	59	COMPLETE DEVELOPMENT OF ADVANCED BLADE AND VANE ALLOYS [illegible]
... ALLOY MELTING WITH VENDORS [illegible]	53	START EXPERIMENTAL ALLOY MELTING WITH VENDORS. Start melting of experimental compositions aimed at improved hardfacing alloy capabilities. Place orders for procurement.	60	COMPLETE DEVELOPMENT OF ADVANCED BLADE AND VANE COATINGS [illegible]
...ATION OF EXPERIMENTAL ALLOYS [illegible]	54	START MECHANICAL PROPERTY AND [illegible] EVALUATION OF EXPERIMENTAL ALLOYS. Start impact, hot hardness and hot wear testing at selected temperatures for comparison of potential hardfacing alloys. Complete test program.	61	COMPLETE DEVELOPMENT OF ADVANCED DISK ALLOY [illegible]
...ING AND HEAT TREAT INVESTIGATION ... ALLOYS [illegible]				
... ALLOY MELTING "IN-HOUSE" [illegible]				



Event Number	Description and Criteria
[illegible]	COMPLETE ADVANCED [illegible] ALLOY DEVELOPMENT [illegible]
[illegible]	CONTINUE MANUFACTURING AND LABORATORY ANALYSES SUPPORT [illegible]
[illegible]	ENGINE FTS [illegible]
58	COMPLETE SUSTAINING ENGINEERING FOR [illegible] FLIGHT TEST [illegible]
[illegible]	CONTINUE DEVELOPMENT OF ADVANCED BLADE AND VANE ALLOYS [illegible]
60	COMPLETE DEVELOPMENT OF ADVANCED BLADE AND VANE COATINGS [illegible]
[illegible]	COMPLETE DEVELOPMENT OF ADVANCED DISK ALLOY [illegible]
[illegible]	COMPLETE DEVELOPMENT OF ADVANCED SHEET ALLOY [illegible]
[illegible]	ENGINE CERTIFICATION [illegible]

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1.20 WEIGHT CONTROL AND STATUS

The JTF17 engine weight program during Phase III will be monitored and controlled as follows:

1. Report engine weight status and weight changes periodically
2. Evaluate all development engine changes for weight effects
3. Perform weight reduction studies to evaluate (1) use of applicable weight reduction concepts in all sections of the engine and (2) incorporation of new materials and new fabrication techniques
4. Perform weight trade-off studies of alternate designs.

All activities involving JTF17 engine weight control, weight studies and weight records are performed by the Design Weights Group. This group is responsible for all effort involving weights and serves to coordinate activities involving parametric studies, weight trade studies, weight control, weight records and design loads.

Preliminary weight estimates are made for all design layouts and parts weights are calculated from detail drawings issued with engineering changes and experimental parts releases. Weight records are then continuously updated. The weight records system is set up in a manner which allows cross-checking for accuracy. Detail weights are revised for all engineering changes and the engineering change records are periodically compared to the latest Bill-of-Materials parts list weight. Actual weights of received parts are compared to calculated weights and any discrepancies are corrected.

All design layouts are also reviewed for possible weight reduction and recommendations are made to the designers. Other weight savings studies are initiated within the group and all items are coordinated in periodic weight reports pointing out the best combination to achieve a minimum weight engine. These reports are not limited to specific intervals, but are issued whenever significant changes in engine weight deem them necessary. Pre-established target weights for each engine section has been effective in promoting weight awareness and in measurement of progress. Regular reports to the program manager measure progress relative to this target weight breakdown.

The major milestones, network chart and event dictionary for weight control and status are shown in figures 39 and 40, respectively.

A detailed description of weight control and status is presented in Weight, Volume III, Report A, Section IV. Test planning and integration is presented in Test, Volume IV, Report E.

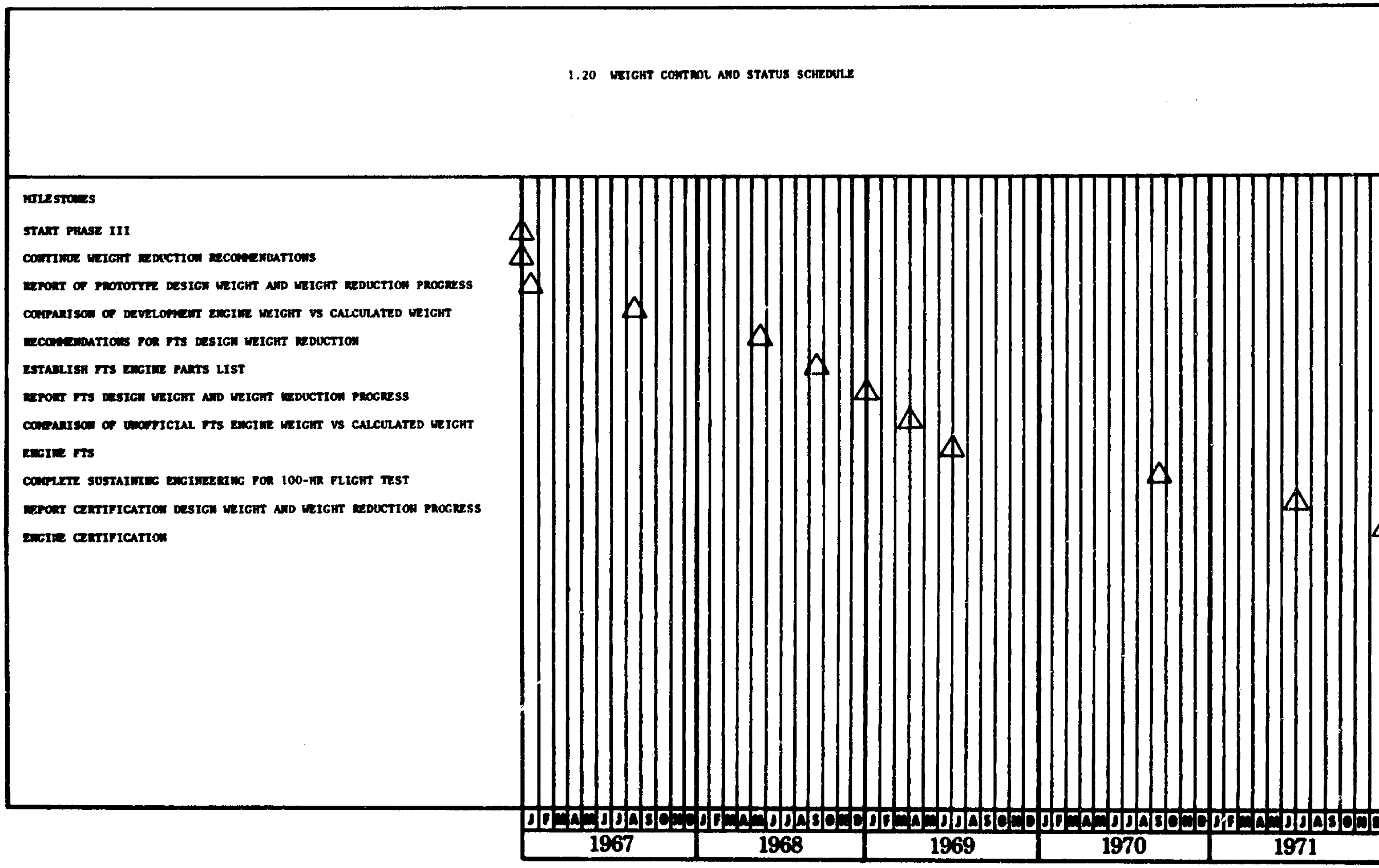

Figure 39. 1.20 Weight Control and Status

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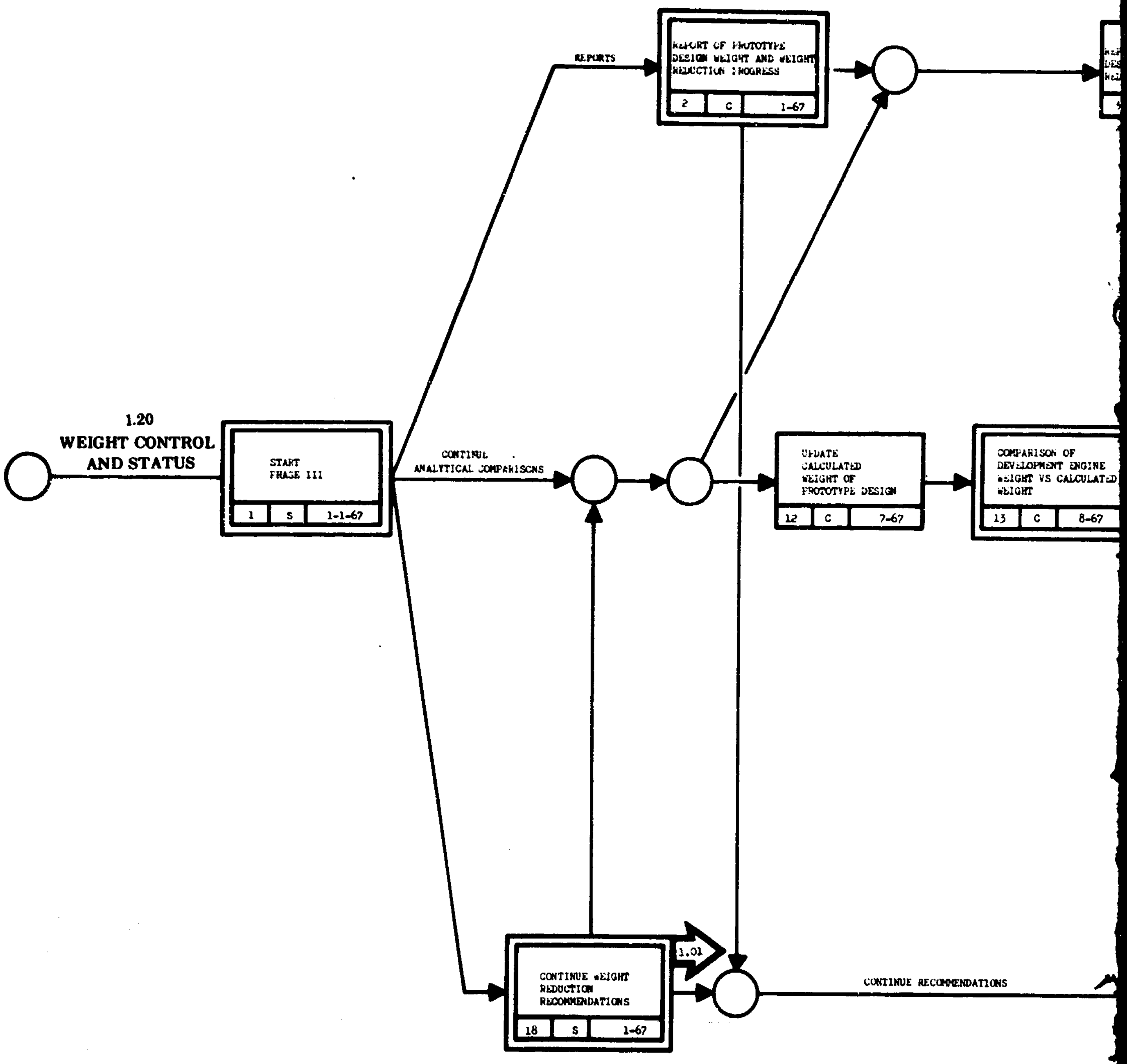
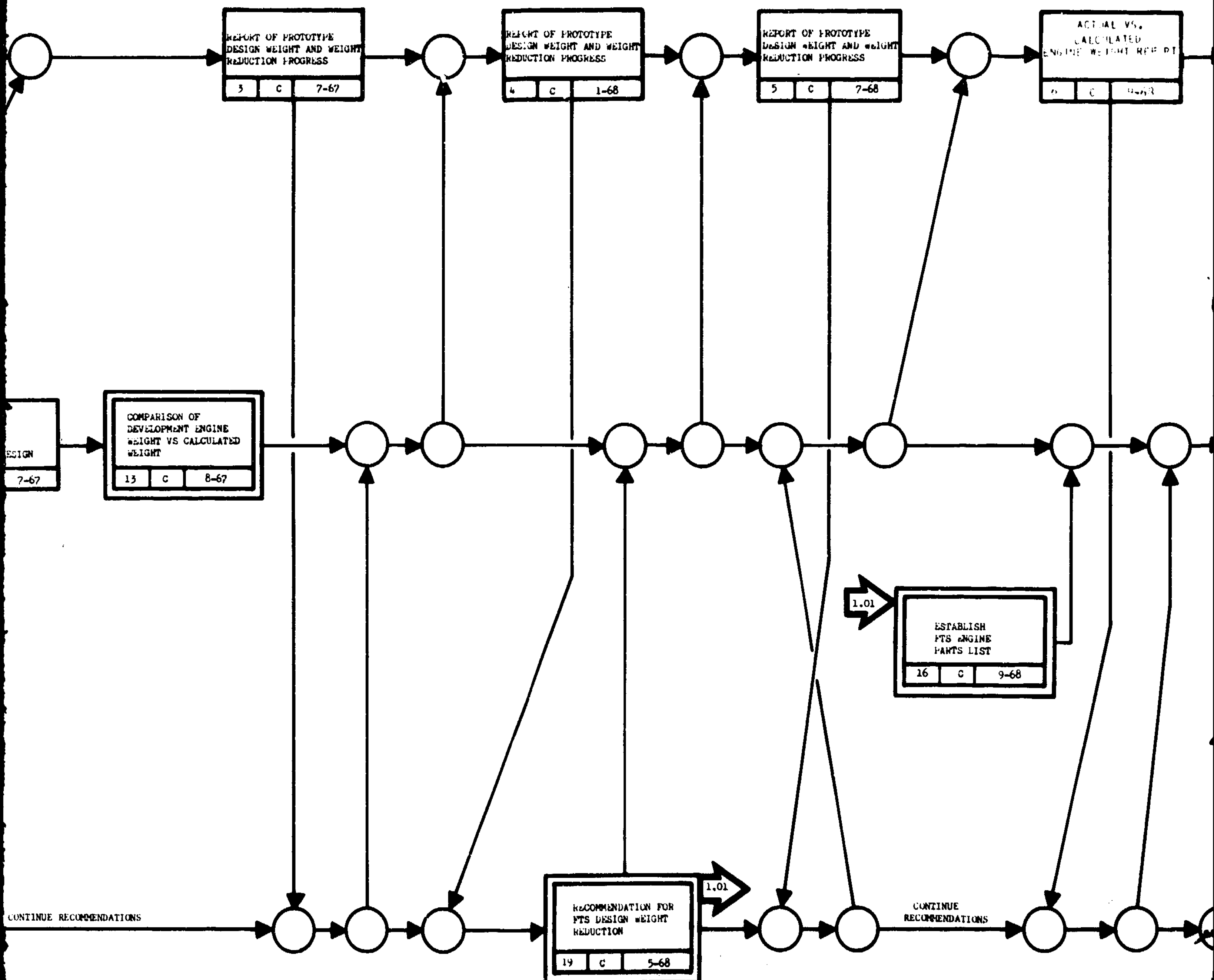


Event Number

Figure 40. 1.20 Weight Control and Status

1.20 Weight Control and S



EVEN
1.20 WEIGHT

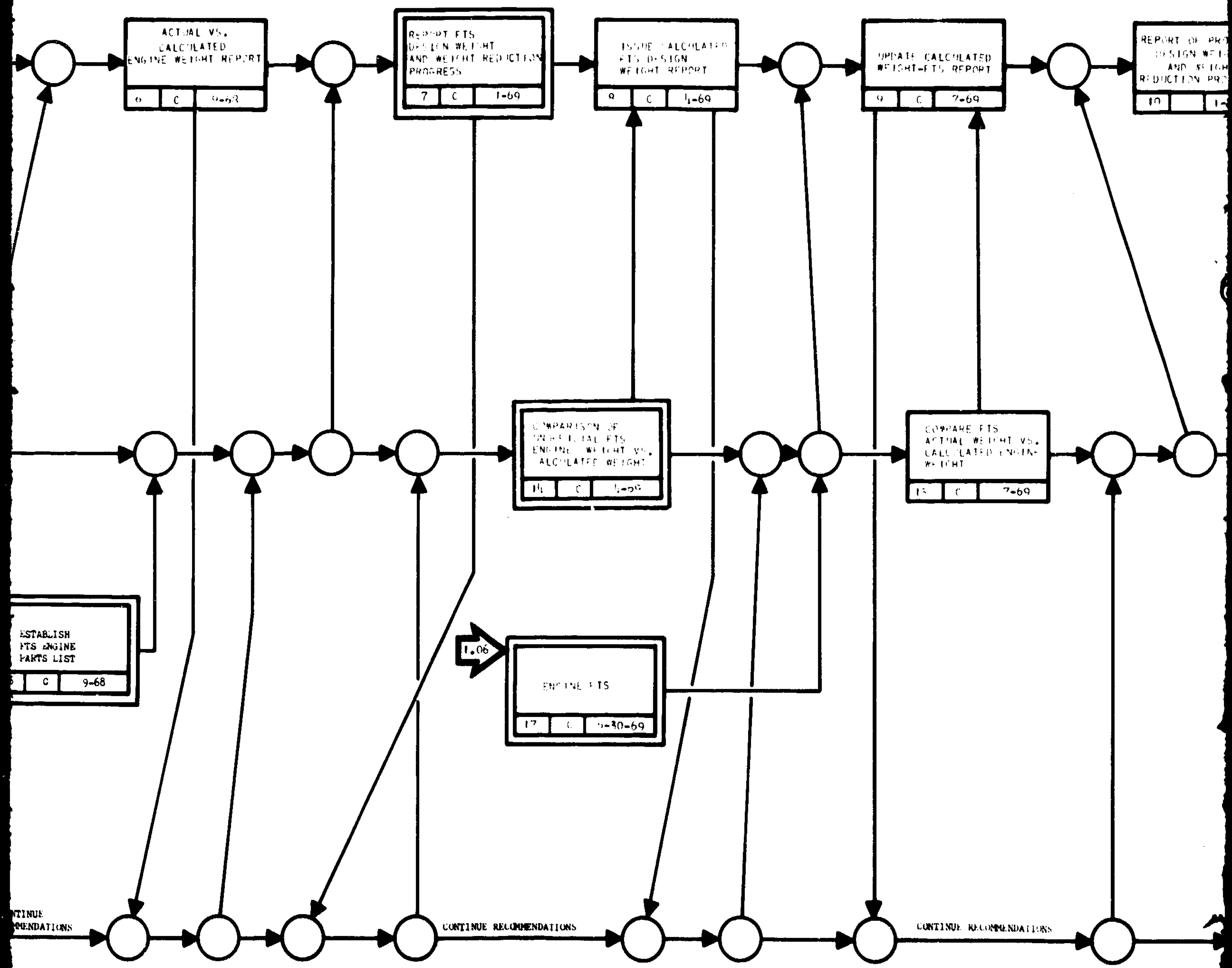
Event Number	Description and Criteria
1	START PHASE III Start of Phase III. Phase III go-ahead received from FAA.
2	REPORT OF PROTOTYPE DESIGN WEIGHT AND WEIGHT REDUCTION PROGRESS Current prototype engine weight including sectional weight breakdown and weight reduction recommendation status. Issuance of report.
3	REPORT OF PROTOTYPE DESIGN WEIGHT AND WEIGHT REDUCTION PROGRESS Current prototype engine weight including sectional weight breakdown and weight reduction recommendation status. Issuance of report.
4	REPORT OF PROTOTYPE DESIGN WEIGHT AND WEIGHT REDUCTION PROGRESS Current prototype engine weight including sectional weight breakdown and weight reduction recommendation status. Issuance of report.

Event Number	Description and Criteria
5	REPORT OF PROTOTYPE DESIGN WEIGHT AND WEIGHT REDUCTION PROGRESS Current prototype engine weight including sectional weight breakdown and weight reduction recommendation status. Issuance of report.
6	ACTUAL VS CALCULATED ENGINE WEIGHT REPORT Comparison of the actual weight and calculated weight for the prototype engine. Issuance of report.
7	REPORT FTS DESIGN WEIGHT AND WEIGHT REDUCTION PROGRESS Provide FTS engine design weight status and weight reduction progress. Issuance of report.
8	ISSUE CALCULATED FTS DESIGN WEIGHT REPORT Updating of current FTS engine weight based on latest engine design. Issuance of report.
9	UPDATE CALCULATED WEIGHT OF FTS DESIGN Updating of prototype engine weight based on FTS engine weight. Issuance of report.

Event Number
10
11
12
13

2

Weight Control and Status Schedule



EVENT DICTIONARY
1.20 WEIGHT CONTROL AND STATUS

nd Criteria

GN WEIGHT AND WEIGHT
weight including ace-
ed weight reduction
Issuance of report.

NE WEIGHT REPORT
weight and calculated
engine. Issuance of

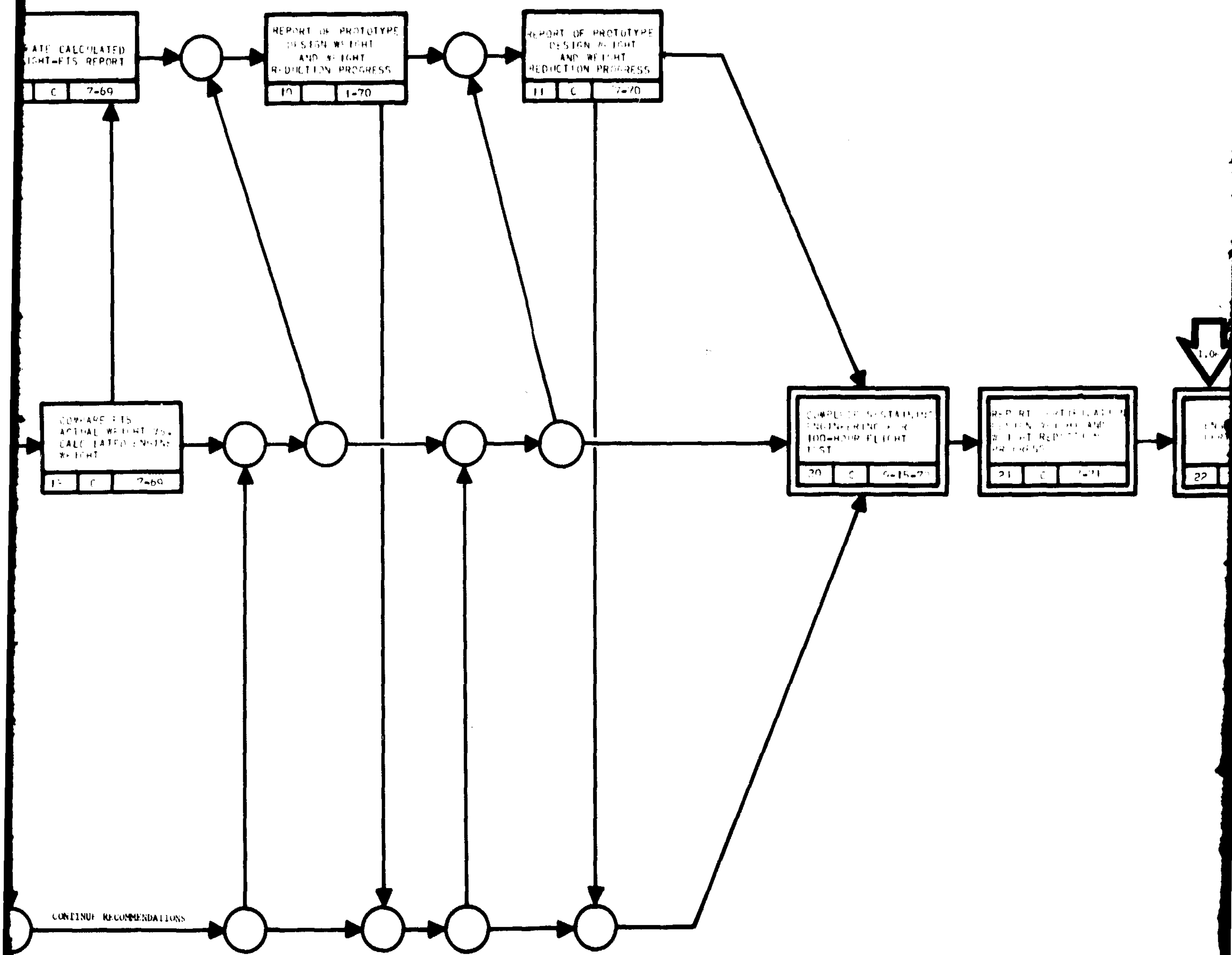
AND WEIGHT REDUCTION
n weight status and weight
uance of report.

GN WEIGHT REPORT
gine weight based on
uance of report.

OF FTS DESIGN
weight based on
nce of report.

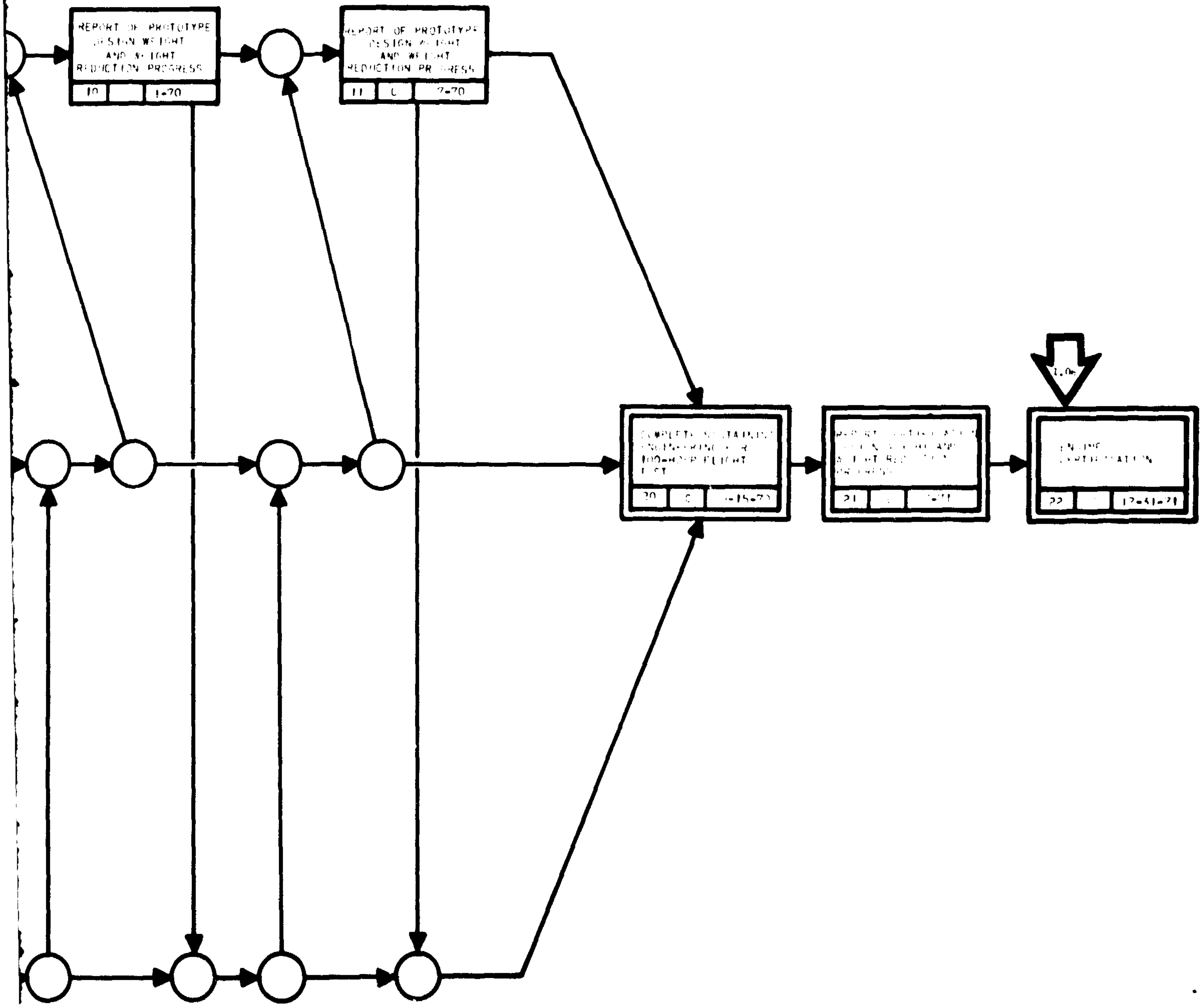
Event Number	Description and Criteria
10	**REPORT OF PROTOTYPE DESIGN WEIGHT AND WEIGHT REDUCTION PROGRESS** Current prototype engine weight including functional weight breakdown and weight reduction recommendation status. Issuance of report.
11	**REPORT OF PROTOTYPE DESIGN WEIGHT AND WEIGHT REDUCTION PROGRESS** Current prototype engine weight including functional weight breakdown and weight reduction recommendation status. Issuance of report.
12	**UPDATE CALCULATED WEIGHT OF PROTOTYPE DESIGN** Updating of prototype engine weight based on latest engine design. Issuance of report.
13	**COMPARISON OF DEVELOPMENT WEIGHT VS CALCULATED WEIGHT** Comparison of the actual weight and calculated weight for the prototype design engine. Issuance of report.

Event Number	Description and Criteria
14	**COMPARISON OF UNOFFICIAL FTS ENGINE WEIGHT VS CALCULATED WEIGHT** Comparison of the actual weight and calculated weight for the unofficial FTS engine. Issuance of report.
15	**COMPARE FTS ACTUAL WEIGHT VS CALCULATED ENGINE WEIGHT** Comparison of FTS actual weight to the corresponding calculated weight. Issuance of report.
16	**ESTABLISH FTS ENGINE PARTS LIST** [illegible]
17	**ENGINE FTS** Reference engine network 1.06 for description and criteria.
18	**CONTINUE WEIGHT REDUCTION RECOMMENDATION** Current weight reduction recommendation including status of these recommendations. Issuance of Weight Reduction Report.
19	**RECOMMENDATION FOR FTS DESIGN WEIGHT REDUCTION** [illegible] for FTS design and report of progress. Issuance of report.



Description and Criteria	Event Number	Description and Criteria
[illegible]	20	COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST [illegible]
[illegible]	21	REPORT CERTIFICATION DESIGN WEIGHT AND WEIGHT REDUCTION PROGRESS [illegible] reports.
[illegible]	22	ENGINE CERTIFICATION [illegible]
[illegible]		
[illegible]		
[illegible] design and report of progress. Issuance of [illegible]		

4


REPORT OF PROTOTYPE DESIGN WEIGHT AND WEIGHT REDUCTION PROGRESS
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1-70
REPORT OF PROTOTYPE DESIGN WEIGHT AND WEIGHT REDUCTION PROGRESS
11
C
7-70
20
C
21
22

5

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SECTION II
MANAGEMENT CONTROLS AND PRODUCT ASSURANCE

2.01 COORDINATION

The integration of the JTF17 engine and systems with the airframe is accomplished through the interaction of the Design, Project, Installation, and Field Engineering groups; by coordination with the airframe contractor; and by coordination with the airlines.

Installation Engineering channels technical information in both directions from Program Management to the airframe manufacturer and engine operators. This is done through the Field Engineers and Flight Operations Engineers who make direct contacts with the airframe manufacturer and engine operators on a continuing basis.

The Installation Engineering groups coordinate the installation design requirements for the JTF17 engine to ensure complete compatibility of the engine-airframe combination relating to installation, performance, operation, reliability, safety, maintainability and economics. In addition, these groups integrate airframe requirements into the normal engineering development and the sustaining engineering programs, which continue after the engines are certificated and enter operational service. An Installation Handbook and Installation Drawings are prepared to define for the airframe manufacturer and the airlines the engine features which must be considered in the design of the aircraft. Thus, the Installation Engineering groups are the clearing house for the engine/airframe technical coordination outlined in the Airframe/Engine Compatibility Agreement described in detail in Volume III, Report D. Test planning and integration is presented in Test, Volume IV, Report E.

These groups also fabricate engine mockups and keep them up-to-date. These mockups are used as aids during the initial design as well as to evaluate the installation compatibility of subsequent changes to the external portion of the engine. These changes are coordinated with the airframe manufacturer before preparing Engineering changes. As these changes are released, the airframe manufacturer is provided with incorporation schedules and revised Installation Drawings which show the physical effects of these changes.

Concurrent with the coordination of engine installation requirements, the Engine Performance Group provides basic engine performance data and performance correction data which permits use of specification data at off-standard conditions with varying ambient temperatures, engine air-bleed flows, accessory power extraction, inlet duct losses, etc. This group also assists the airframe manufacturer by reviewing and commenting on ground and flight test data. Engine Operating Instructions along with powerplant simulator information are also provided by this group as changes are made and prior to installed engine operation.

Installation Engineering groups also coordinate with the airframe manufacturer and the accessory manufacturers the requirements and specifications pertaining to special airframe required, engine-mounted accessories.

The major milestones are shown below:

Complete Engine FTS	30 June 1969
Complete Engine Certification	31 December 1971
Complete 100-Hour Flight Test Program	15 September 1970
Aircraft Certification	15 May 1974

2.02 MAINTAINABILITY AND HUMAN ENGINEERING

MAINTAINABILITY

The Maintainability Program provides the effort to ensure a maintainable powerplant throughout all phases of the JTF17 engine program from design inception through operational service and is described in detail in Volume IV, Report F, Section I. This program encompasses the following effort:

1. Establishment of maintainability objectives and requirements
2. Prediction, assurance and verification of maintainability objectives and goals
3. Integration of maintainability group activities under the direction of a maintainability engineer.

The major objectives of the Maintainability Program are to reduce engine maintenance costs and minimize engine-chargeable down time. These objectives are to be achieved by integration of features into the engine design to reduce the frequency and the time required for engine maintenance; thus assuring the maximum availability of the supersonic transport aircraft during prime operating periods.

HUMAN ENGINEERING

Human Engineering objectives in the Supersonic Transport Program are to amplify and sustain personnel effectiveness during the manufacture, operation and maintenance of the JTF17 engine. Human Engineering is primarily associated with maintainability and is an identifiable function of each maintainability group. The Human Engineering Program is a continuation and expansion of the effort established in Phase II-C and is described in detail in Volume IV, Report D.

The objective of the Human Engineering Plan is to integrate the principles of human physical and psychological characteristics into the engine and ground equipment design. This integration ensures that maximum man-equipment efficiency and safety is designed into all engine components and maintenance equipment.

The Human Engineering effort is guided by MIL-STD-803A and emphasizes personnel convenience and safety, man-equipment accuracy and the combined man-equipment capability. The basic operations for accomplishing the goals of the Human Engineering Program are:

1. Personnel orientation in Human Engineering philosophy
2. Engine and equipment design review
3. Continuing review of engine and component mockups
4. Review of all engine changes
5. Survey of existing engines for improved Human Engineering features
6. Investigation of internal and field problem reports.

In-flight factors, such as internal component containment and cabin air purity, are included in the Safety Program described in Volume IV, Report C.

The major milestones, network chart and event dictionary for the maintainability and Human Engineering Program are shown in figures 1 and 2 respectively.

Test planning and integration of maintainability and Human Engineering is presented in Test, Volume IV, Report E.

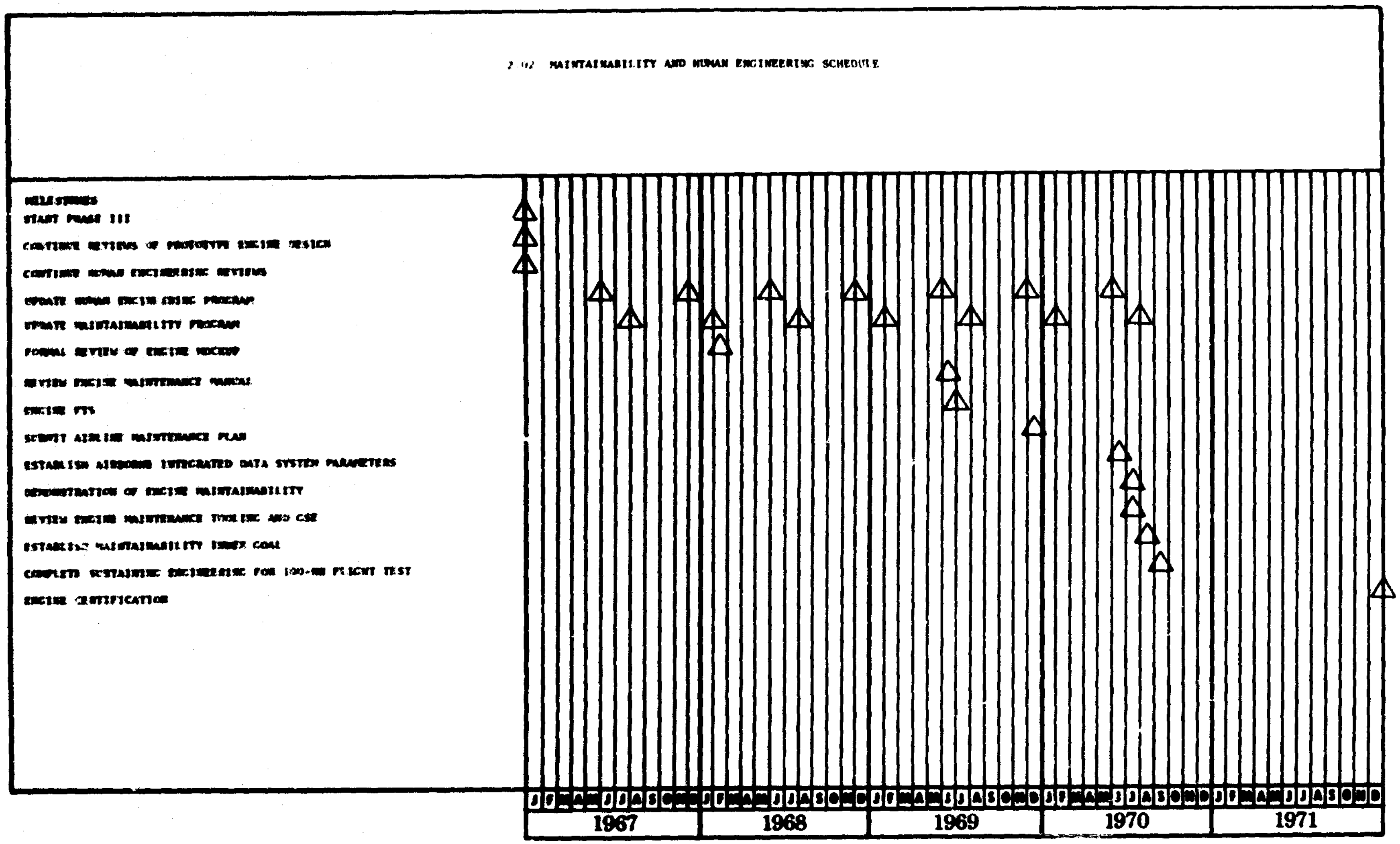

Figure 1. 2.02 Maintainability and Human Engineering

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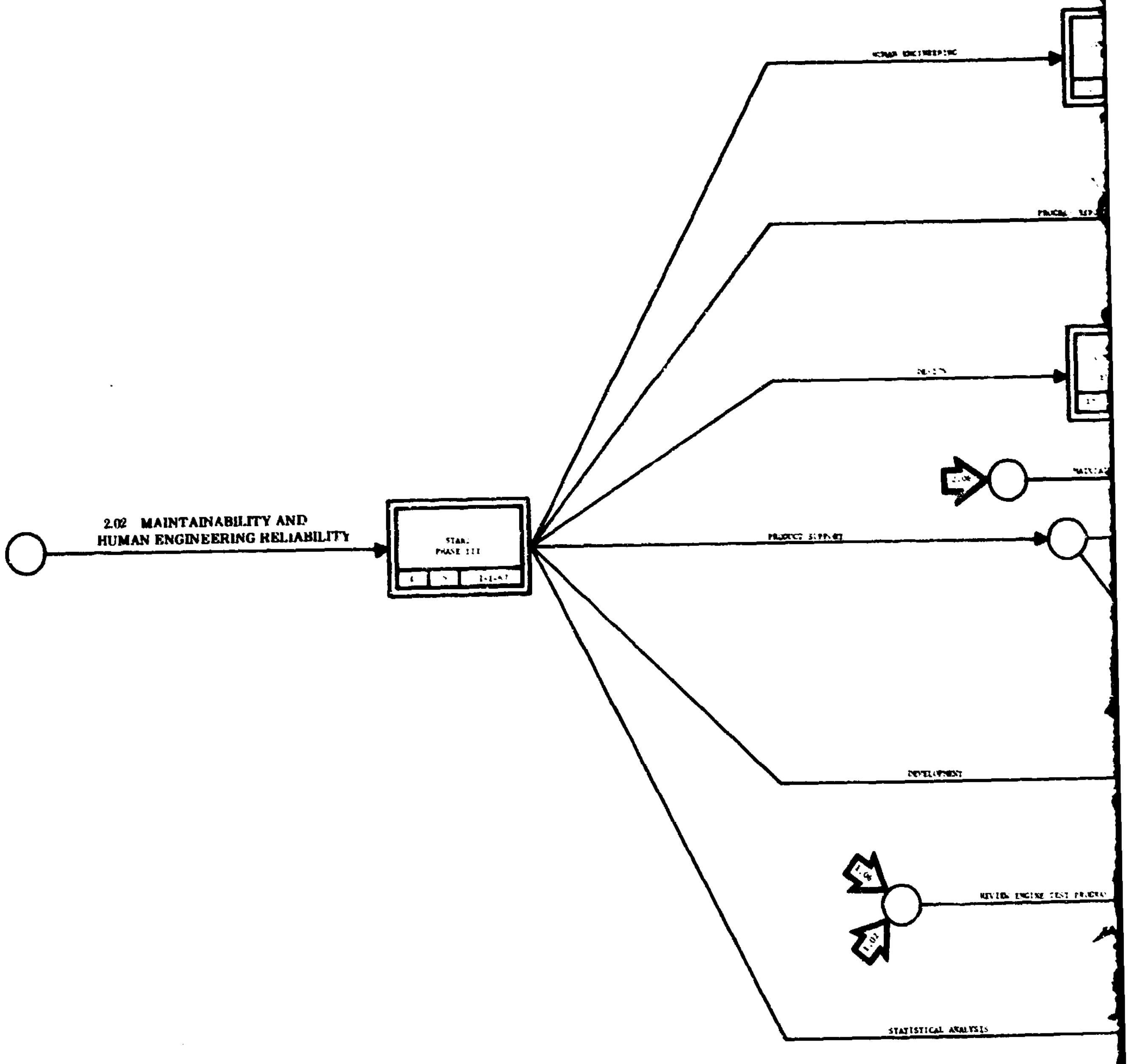
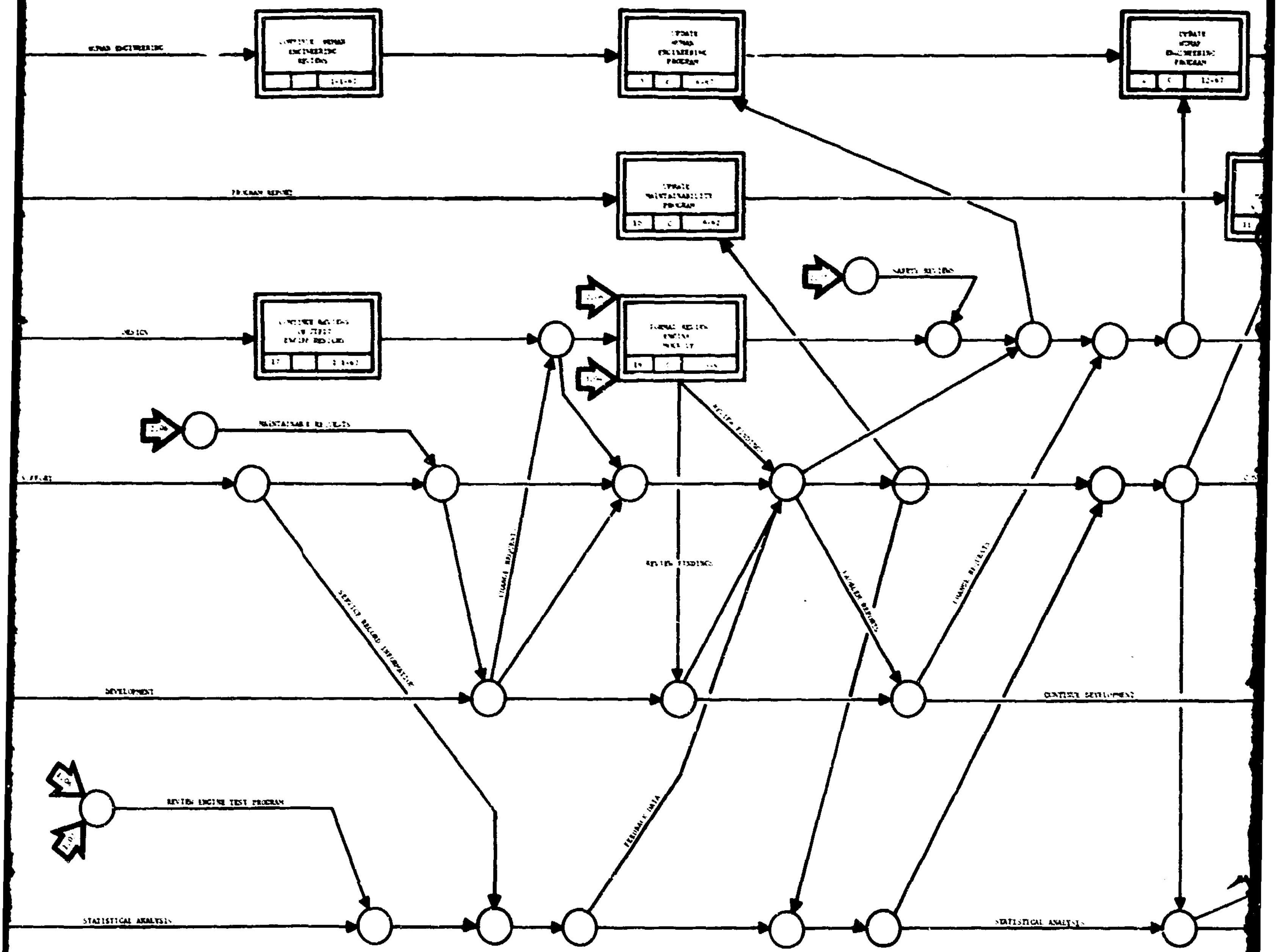
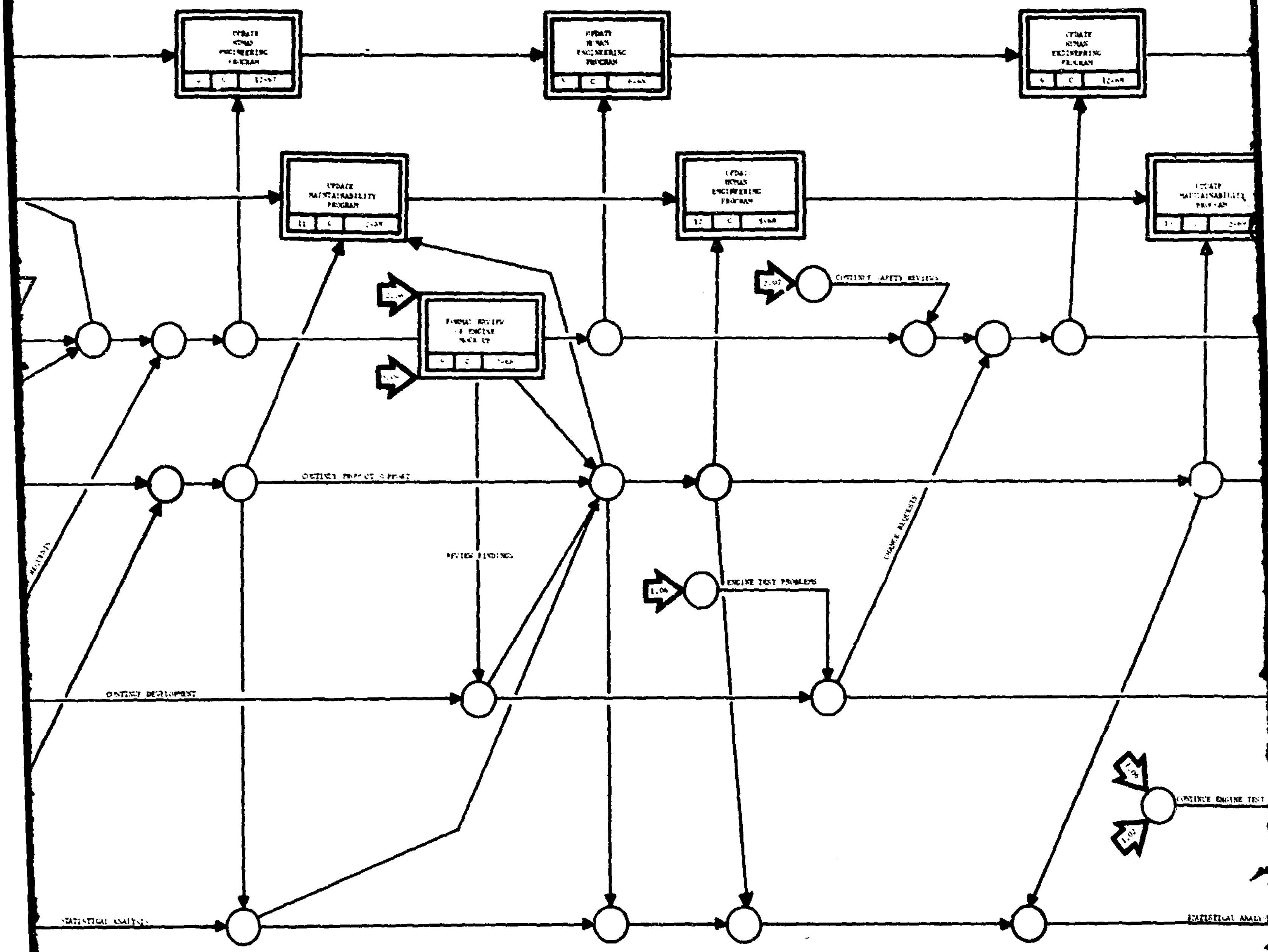


Figure 2. 2.02 Maintainability and Human Engineering



Event Number	Description and Criteria
1	**START PHASE III** Start of Phase III. Phase III go-ahead received from FAA
2	**CONTINUE HUMAN ENGINEERING REVIEW** Define all areas affecting human engineering during development testing. Compile list of action taken to remove hazards and improve human engineering features
3	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup review.
4	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup review.
5	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup review.
6	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup review.
[illegible]	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup review.
8	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup review.

2.02 Maintainability and Human Engineering



EVENT DICTIONARY
2.02 MAINTAINABILITY AND HUMAN ENGINEERING

Event Number	Description and Criteria
[illegible]	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup reviews.
[illegible]	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup reviews.
[illegible]	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup reviews.
[illegible]	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup reviews.
9	**UPDATE HUMAN ENGINEERING PROGRAM** Update engine human engineering program to reflect action taken to resolve hazards during development testing. Include results of safety reviews and design mockup reviews.
10	**UPDATE MAINTAINABILITY PROGRAM** A semi-annual report covering progress in the maintainability program is provided. Issuance of report.
11	**UPDATE MAINTAINABILITY PROGRAM** A semi-annual report covering progress in the maintainability program is provided. Issuance of report.
12	**UPDATE MAINTAINABILITY PROGRAM** A semi-annual report covering progress in the maintainability program is provided. Issuance of report.
13	**UPDATE MAINTAINABILITY PROGRAM** A semi-annual report covering progress in the maintainability program is provided. Issuance of report.
14	**UPDATE MAINTAINABILITY PROGRAM** A semi-annual report covering progress in the maintainability program is provided. Issuance of report.
15	**UPDATE MAINTAINABILITY PROGRAM** A semi-annual report covering progress in the maintainability program is provided. Issuance of report.
16	**UPDATE MAINTAINABILITY PROGRAM** A semi-annual report covering progress in the maintainability program is provided. Issuance of report.
17	**CONTINUE REVIEWS OF JTF17 ENGINE DESIGN** Continue reviews of JTF17 engine design to assure incorporation of maintainability features. Maintainability features are incorporated in pattern drawings.
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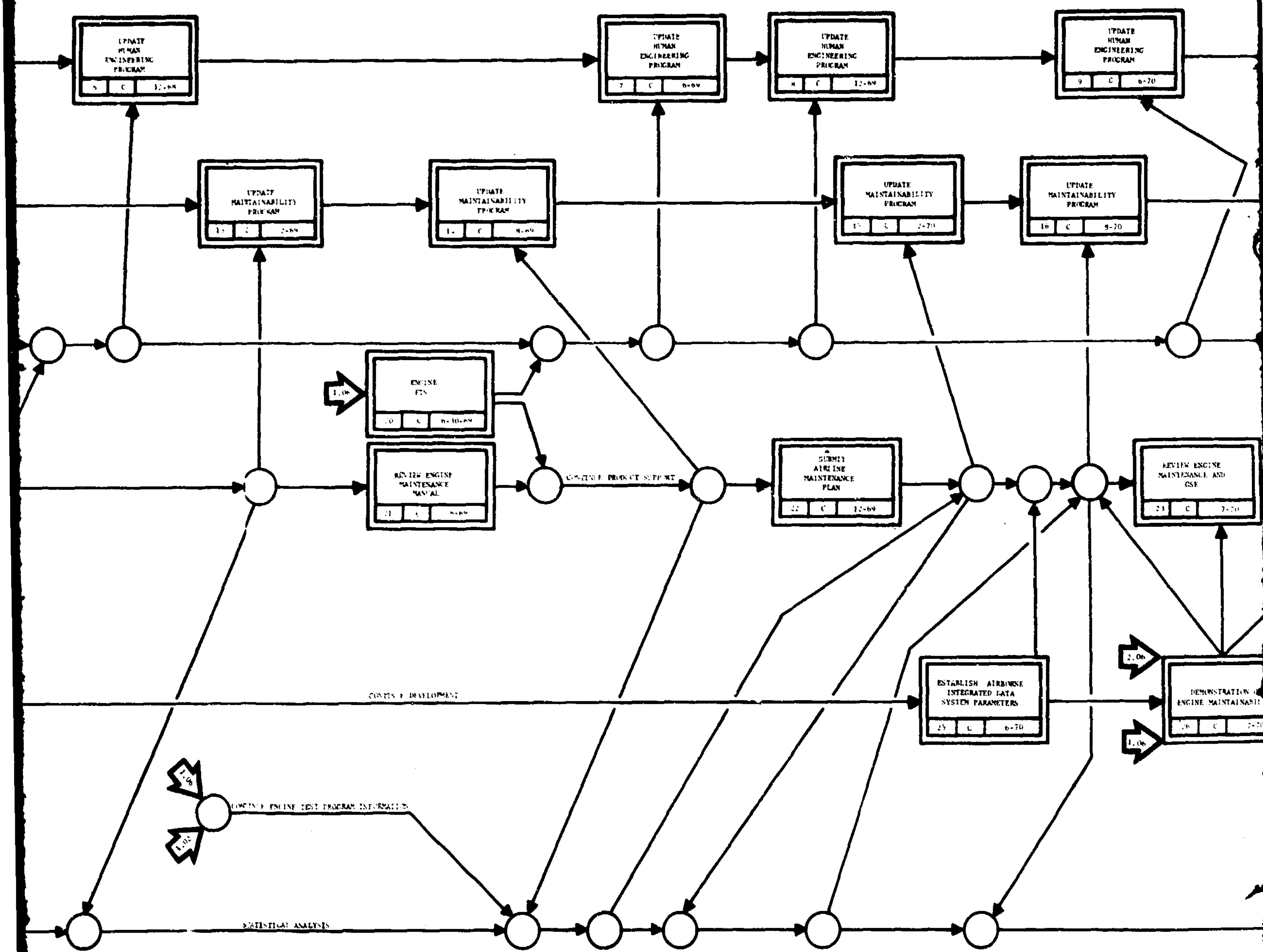
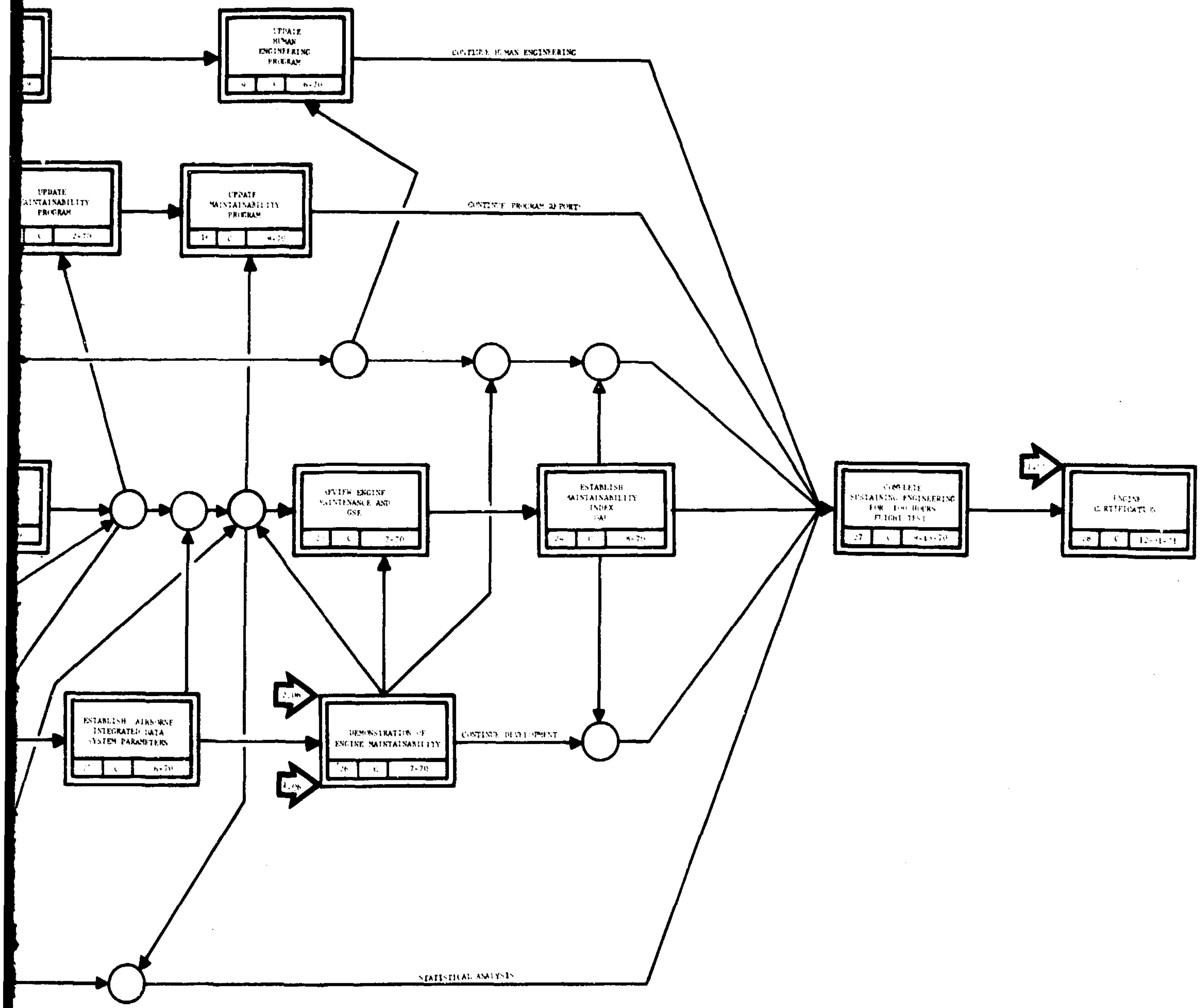
23	



Event Number	Description and Criteria	Event Number	Description and Criteria
18	**FORMAL REVIEW OF ENGINE MOCKUP** Conduct a formal review of the engine mockup. Complete formal review.	24	**ESTABLISH MAINTAINABILITY GOAL INDEX** Estimate maintenance manhours per engine flight hour for mature engine in commercial service. Complete the estimate.
19	**FORMAL REVIEW OF ENGINE MOCKUP** Conduct a formal review of the engine mockup. Complete formal review.	25	**ESTABLISH AIRBORNE INTEGRATED DATA SYSTEM PARAMETERS** Establish parameters for airborne integrated data system. Prepare a list of parameters.
20	**ENGINE FTS** Reference engine network 1.06 for description and criteria.	26	**DEMONSTRATION OF ENGINE MAINTAINABILITY** Demonstrate the inspection and maintenance features of the engine to the FAA, airlines, and airframe personnel. Complete the demonstration.
21	**REVIEW ENGINE MAINTENANCE MANUAL** Review engine maintenance manual to verify incorporation of desired maintainability features. Complete review of manual.	27	**COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST** End Phase III: completion of 100 hours of flight testing.
22	**SUBMIT AIRLINE MAINTENANCE PLAN** Prepare an engine maintenance plan for use by the airlines. Submit plan.	28	**ENGINE CERTIFICATION** Reference engine network 1.06 for description and criteria.
23	**REVIEW OF ENGINE MAINTAINABILITY TOOLING AND GSE** Conduct a review of engine maintainability tooling and aircraft support equipment. Complete the review.		

4


UPDATE HUMAN ENGINEERING PROGRAM
CONTINUE HUMAN ENGINEERING
UPDATE MAINTAINABILITY PROGRAM
UPDATE MAINTAINABILITY PROGRAM
CONTINUE PROGRAM REPORTS
ESTABLISH MAINTAINABILITY INDEX
CONTINUE DEVELOPMENT
ESTABLISH AIRBORNE INTEGRATED DATA SYSTEM PARAMETERS
DEMONSTRATION OF ENGINE MAINTAINABILITY
COMPLETE SUSTAINING ENGINEERING FOR 100 HOURS FLIGHT TEST
STATISTICAL ANALYSIS

2.03 RELIABILITY

Reliability encompasses the management control and engineering functions that ensure compliance with the reliability goals of the JTF17 engine. It is accepted that every useful reliability technique must be employed to meet these requirements. Emphasis has been placed on program visibility, computerized information retrieval systems and the statistical reliability assessment.

To improve management control a reliability organization has been created under the Product Assurance Manager. The Chief of Reliability and Safety reports to the Product Assurance Manager and is responsible for all reliability analysis, assessment and reporting. The Design Reliability Group and the Development Reliability Group receive their technical direction from the Reliability Engineer. All reliability activities are described in detail in the Reliability Program Plan, Volume IV, Report F, Section II and are listed below:

A. Design Reliability Activities

1. Design Review
2. Reliability Trade Studies
3. Reliability Block Diagrams
4. Failure Mode and Effect Analysis
5. Reliability Apportionment
6. Reliability Mathematical Models
7. Review Historical Data

B. Development Reliability Activities

1. Failure Data Analysis
2. Critical Parts History
3. Reliability Assessment
4. Reliability Problem Files
5. Statistical Engineering

C. Joint Reliability Activities

1. Reliability Training
2. Coordination Airframe-Engine Reliability Interface
3. Vendor Reliability Control
4. Reliability Reporting

The major milestones, network chart and event dictionary for the reliability program are shown in figures 3 and 4, respectively.

Test planning and integration of reliability is presented in Test, Volume IV, Report E.

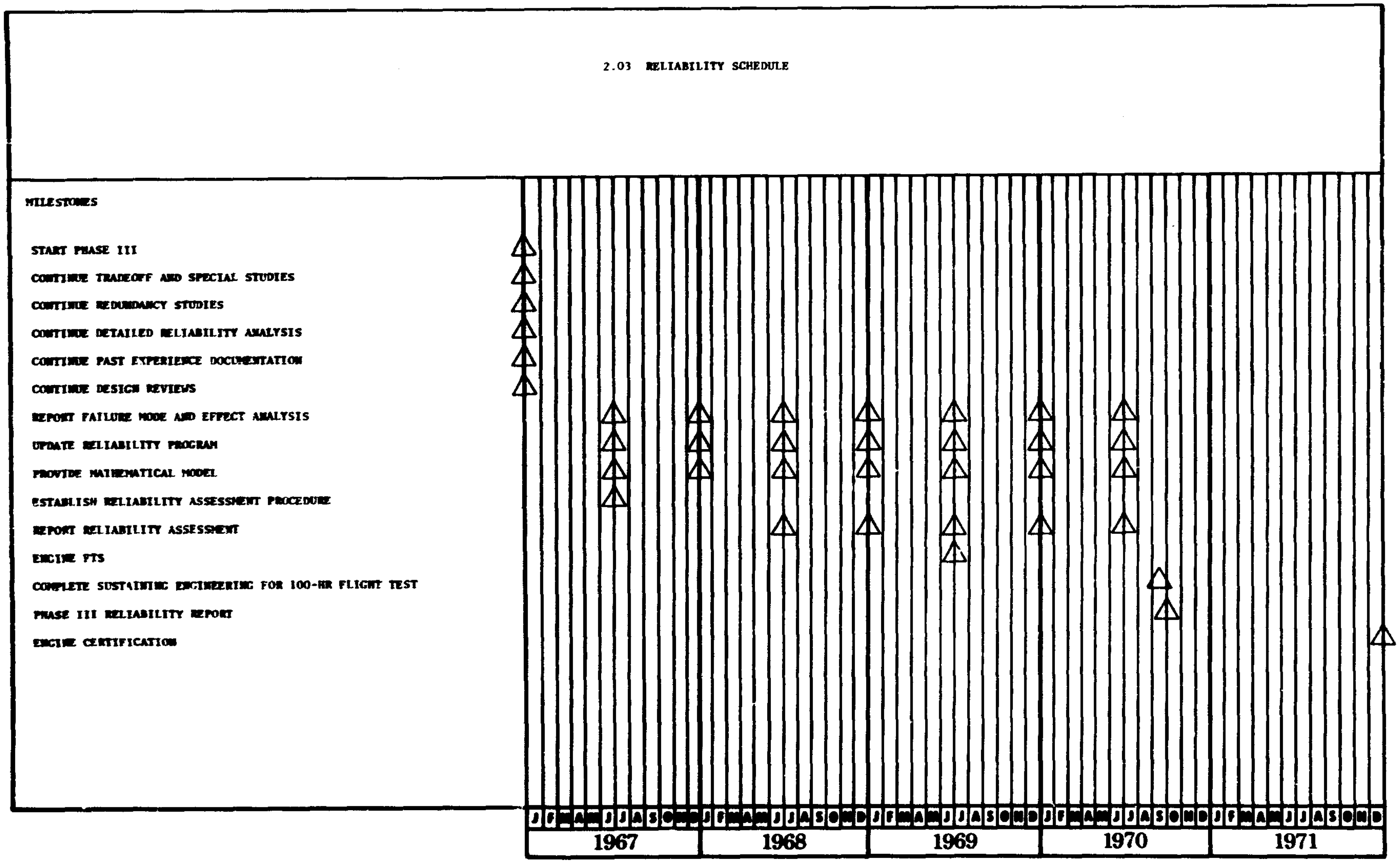


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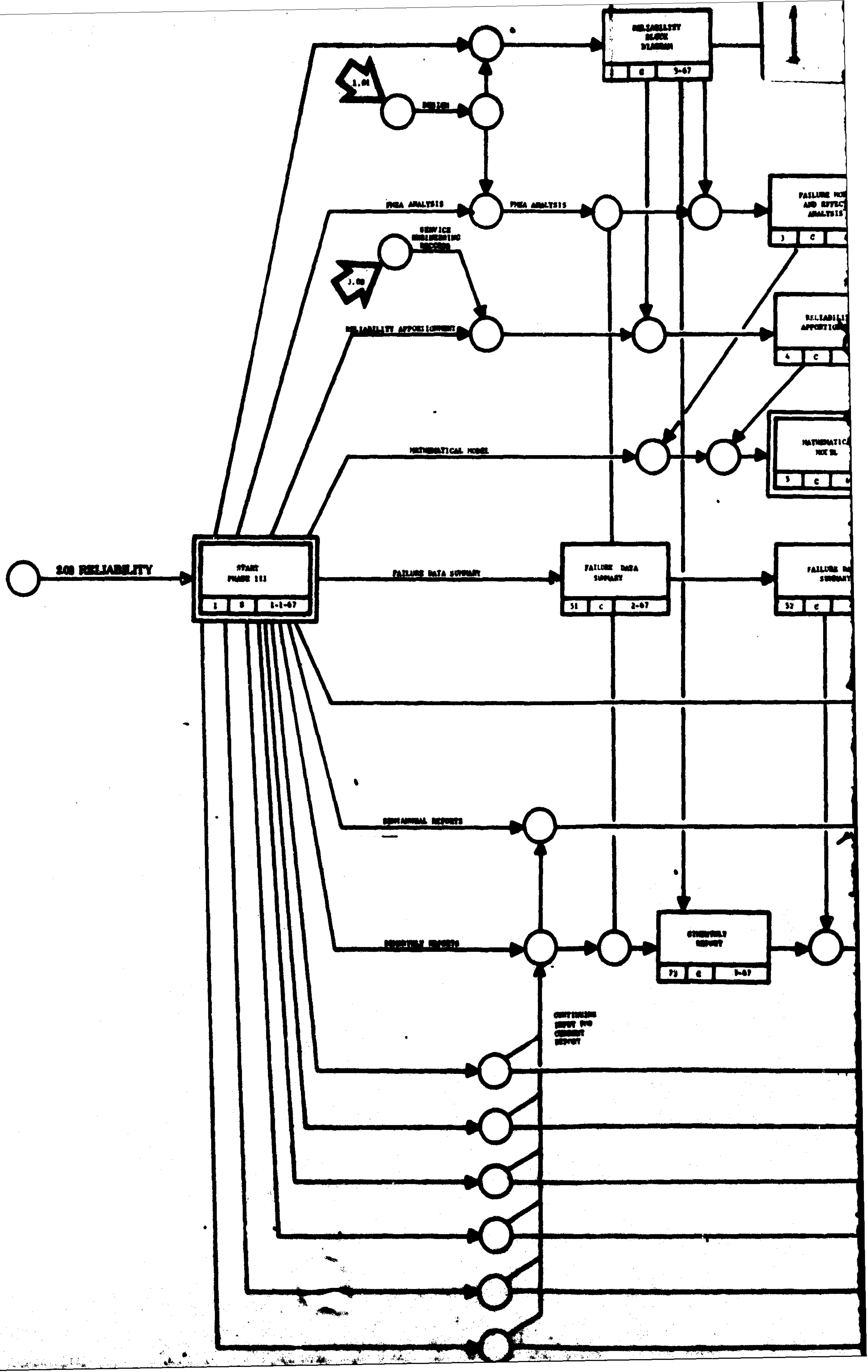
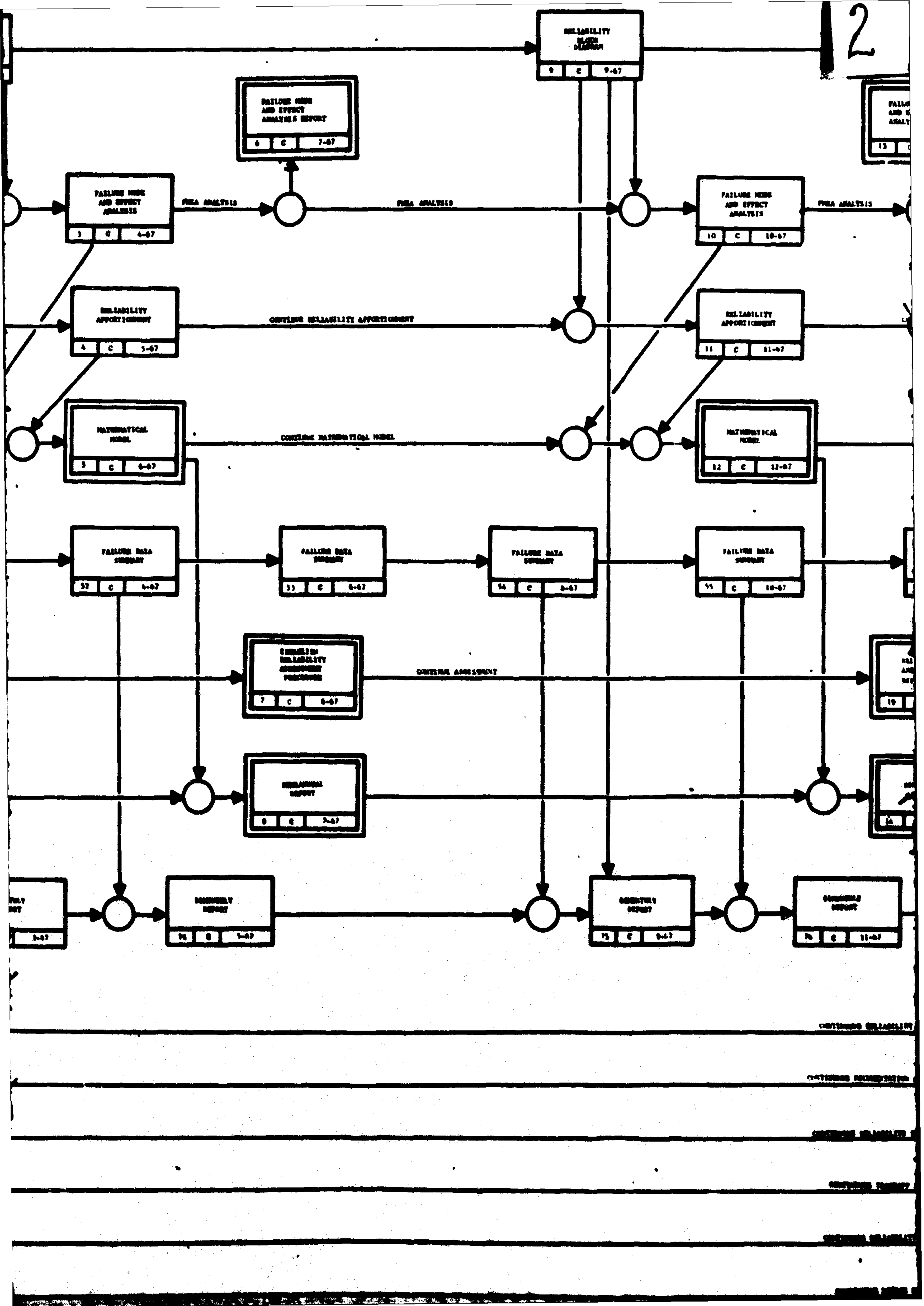
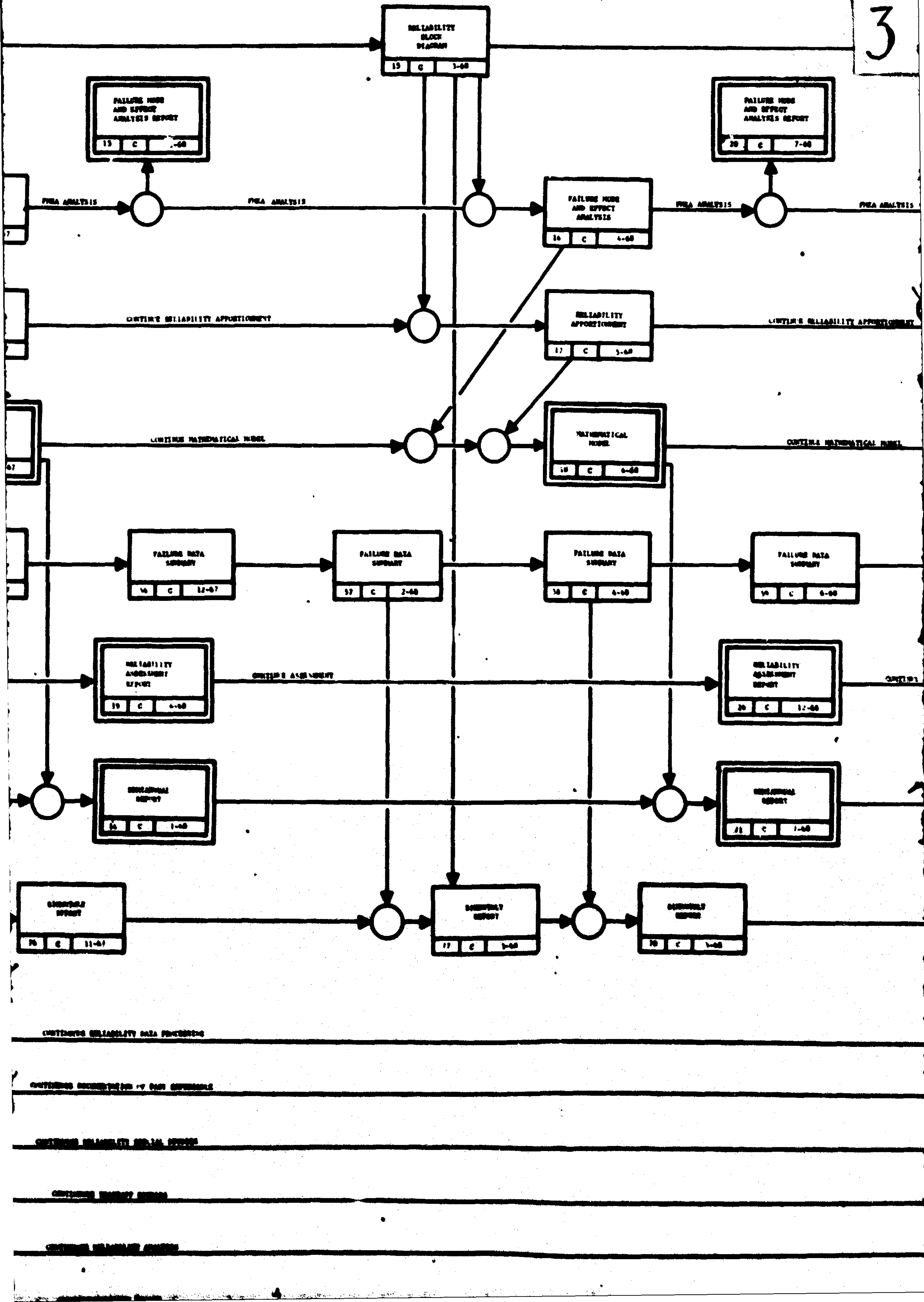
Figure 3. 2.03 Reliability

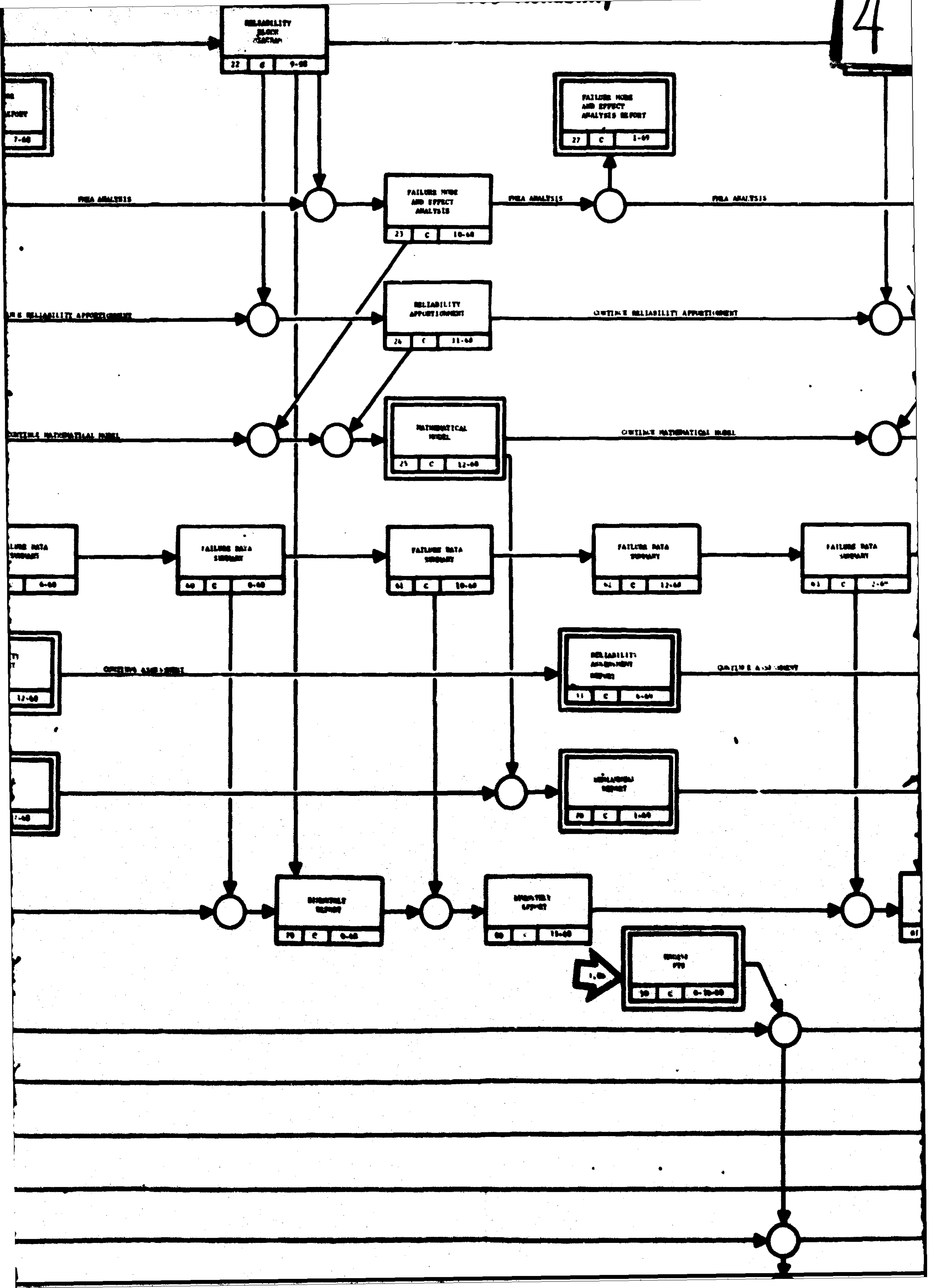


RELIABILITY
START
FAILURE DATA SUMMARY
FAILURE DATA
SUMMARY
MATHEMATICAL MODEL
FMEA ANALYSIS
FMEA ANALYSIS
RELIABILITY APPORTIONMENT
RELIABILITY BLOCK DIAGRAM
1.04
3.08

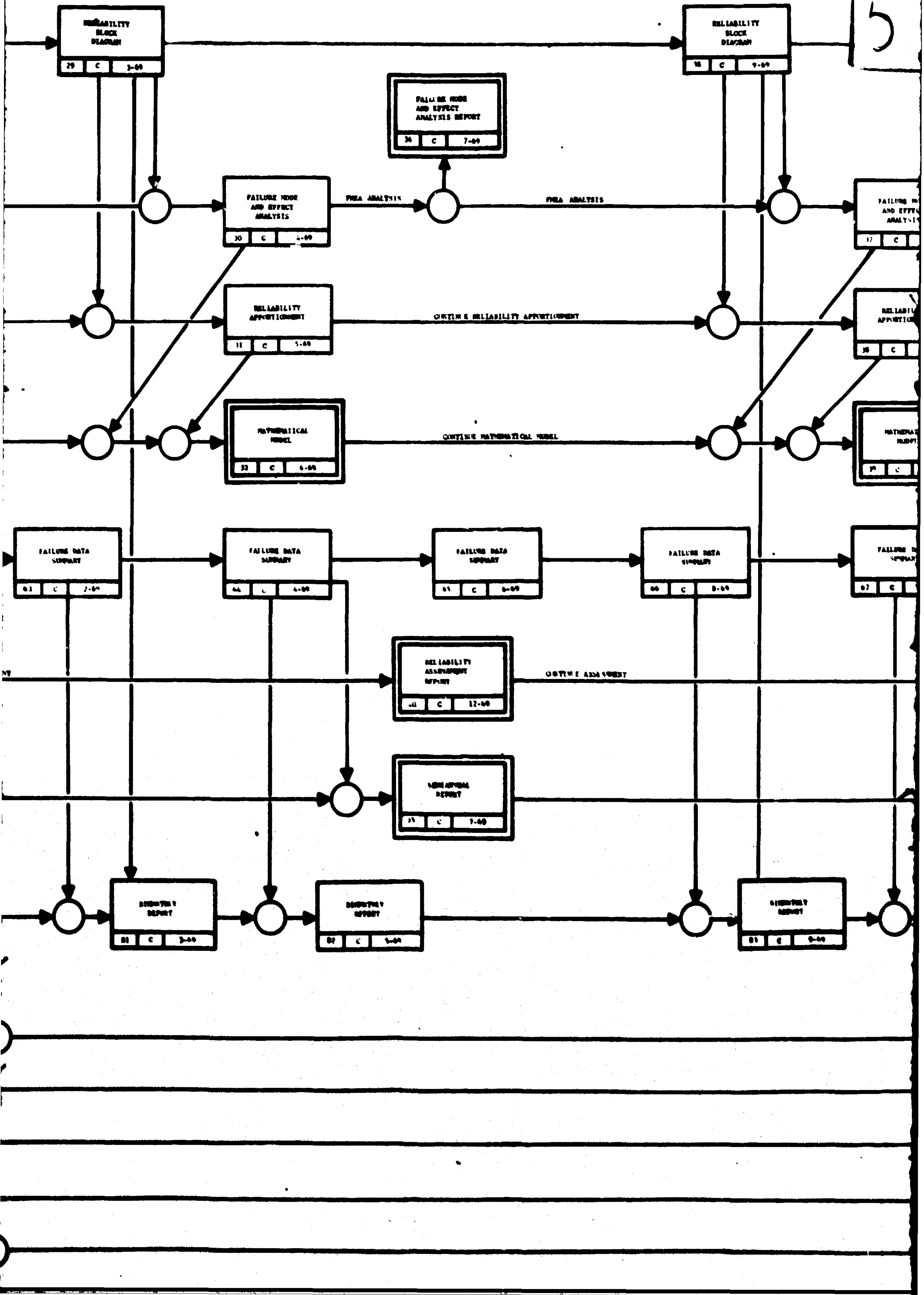

12
RELIABILITY BLOCK DIAGRAM
9 C 9-67
FAILURE MODE AND EFFECT ANALYSIS REPORT
6 C 7-67
FAILURE MODE AND EFFECT ANALYSIS
3 C 4-67
FMEA ANALYSIS
FMEA ANALYSIS
FAILURE MODE AND EFFECT ANALYSIS
10 C 10-67
FMEA ANALYSIS
RELIABILITY APPORTIONMENT
4 C 5-67
CONTINUE RELIABILITY APPORTIONMENT
RELIABILITY APPORTIONMENT
11 C 11-67
MATHEMATICAL MODEL
5 C 6-67
CONTINUE MATHEMATICAL MODEL
MATHEMATICAL MODEL
12 C 12-67
FAILURE DATA SUMMARY
52 C 4-67
FAILURE DATA SUMMARY
53 C 6-67
FAILURE DATA SUMMARY
FAILURE DATA SUMMARY
10-67
7 C 6-67
CONTINUE ASSESSMENT
SEMIANNUAL REPORT
8 C 7-67


RELIABILITY BLOCK DIAGRAM
FAILURE MODE AND EFFECT ANALYSIS REPORT
FMEA ANALYSIS
FAILURE MODE AND EFFECT ANALYSIS
RELIABILITY APPORTIONMENT
MATHEMATICAL MODEL
FAILURE DATA SUMMARY
RELIABILITY ASSESSMENT REPORT

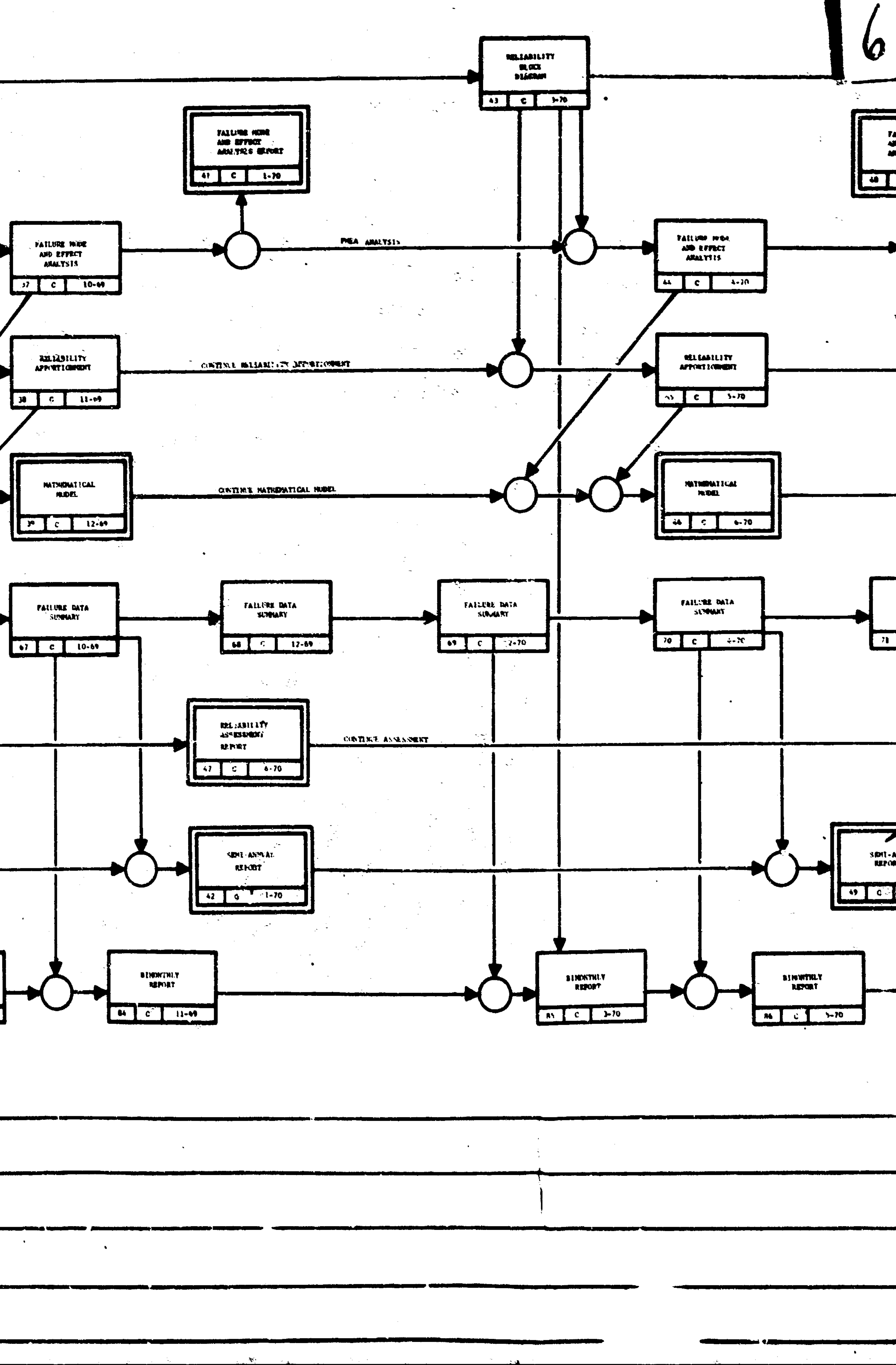
14



RELIABILITY BLOCK DIAGRAM
FAILURE MODE AND EFFECT ANALYSIS REPORT
FMEA ANALYSIS
FAILURE MODE AND EFFECT ANALYSIS
FMEA ANALYSIS
FMEA ANALYSIS
RELIABILITY APPORTIONMENT
CONTINUE RELIABILITY APPORTIONMENT
CONTINUE MATHEMATICAL MODEL
MATHEMATICAL MODEL
CONTINUE MATHEMATICAL MODEL
FAILURE DATA SUMMARY
FAILURE DATA SUMMARY
FAILURE DATA SUMMARY
FAILURE DATA SUMMARY
FAILURE DATA SUMMARY
CONTINUE ASSESSMENT
RELIABILITY ASSESSMENT REPORT
CONTINUE ASSESSMENT
MONTHLY REPORT
MONTHLY REPORT



RELIABILITY BLOCK DIAGRAM
FAILURE MODE AND EFFECT ANALYSIS REPORT
FAILURE MODE AND EFFECT ANALYSIS
FMEA ANALYSIS
FMEA ANALYSIS
RELIABILITY APPORTIONMENT
CONTINUE RELIABILITY APPORTIONMENT
MATHEMATICAL MODEL
CONTINUE MATHEMATICAL MODEL
FAILURE DATA SUMMARY
RELIABILITY ASSESSMENT REPORT
CONTINUE ASSESSMENT


6
RELIABILITY BLOCK DIAGRAM
43 C 3-70
FAILURE MODE AND EFFECT ANALYSIS REPORT
41 C 1-70
FAILURE MODE AND EFFECT ANALYSIS
37 C 10-69
FMEA ANALYSIS
FAILURE MODE AND EFFECT ANALYSIS
44 C 4-70
RELIABILITY APPORTIONMENT
38 C 11-69
CONTINUE RELIABILITY APPORTIONMENT
RELIABILITY APPORTIONMENT
45 C 5-70
MATHEMATICAL MODEL
39 C 12-69
CONTINUE MATHEMATICAL MODEL
MATHEMATICAL MODEL
46 C 6-70
FAILURE DATA SUMMARY
67 C 10-69
FAILURE DATA SUMMARY
68 C 12-69
FAILURE DATA SUMMARY
69 C
FAILURE DATA SUMMARY
70 C
71
RELIABILITY ASSESSMENT REPORT
47 C 6-70
CONTINUE ASSESSMENT
SEMI-ANNUAL REPORT
42
49
BIMONTHLY REPORT
84 C 11-69
BIMONTHLY REPORT
C 3-70
BIMONTHLY REPORT
86 C 5-70

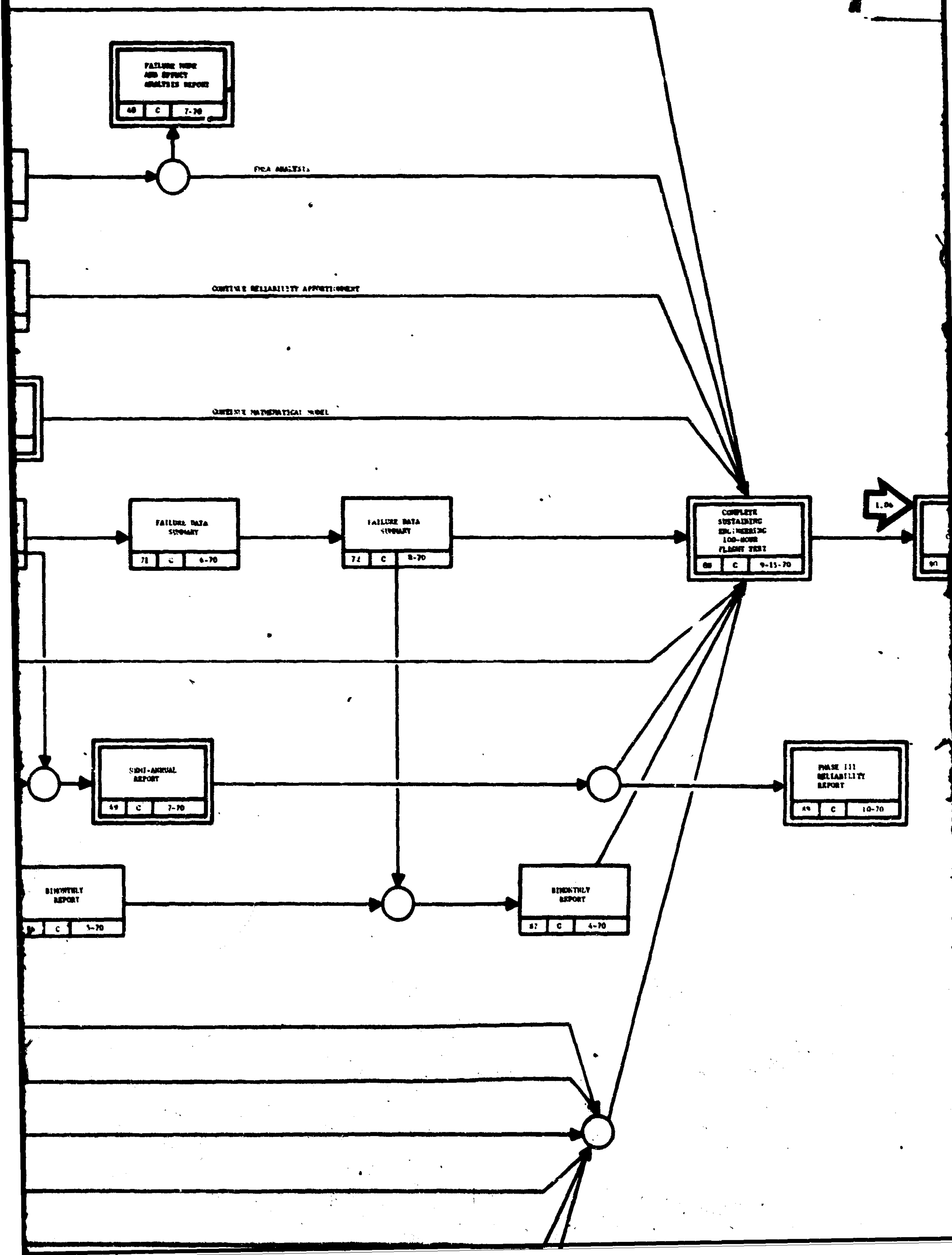
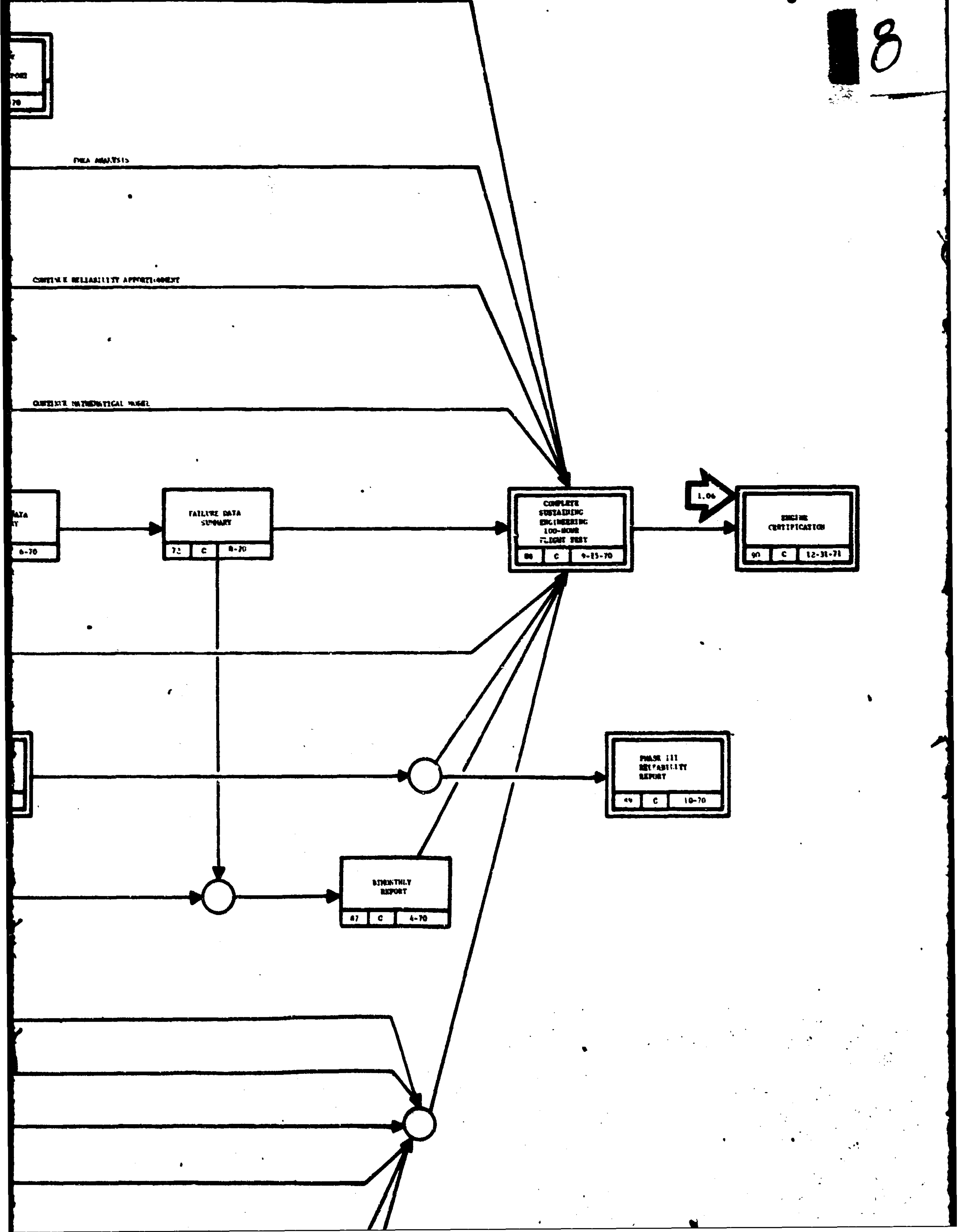
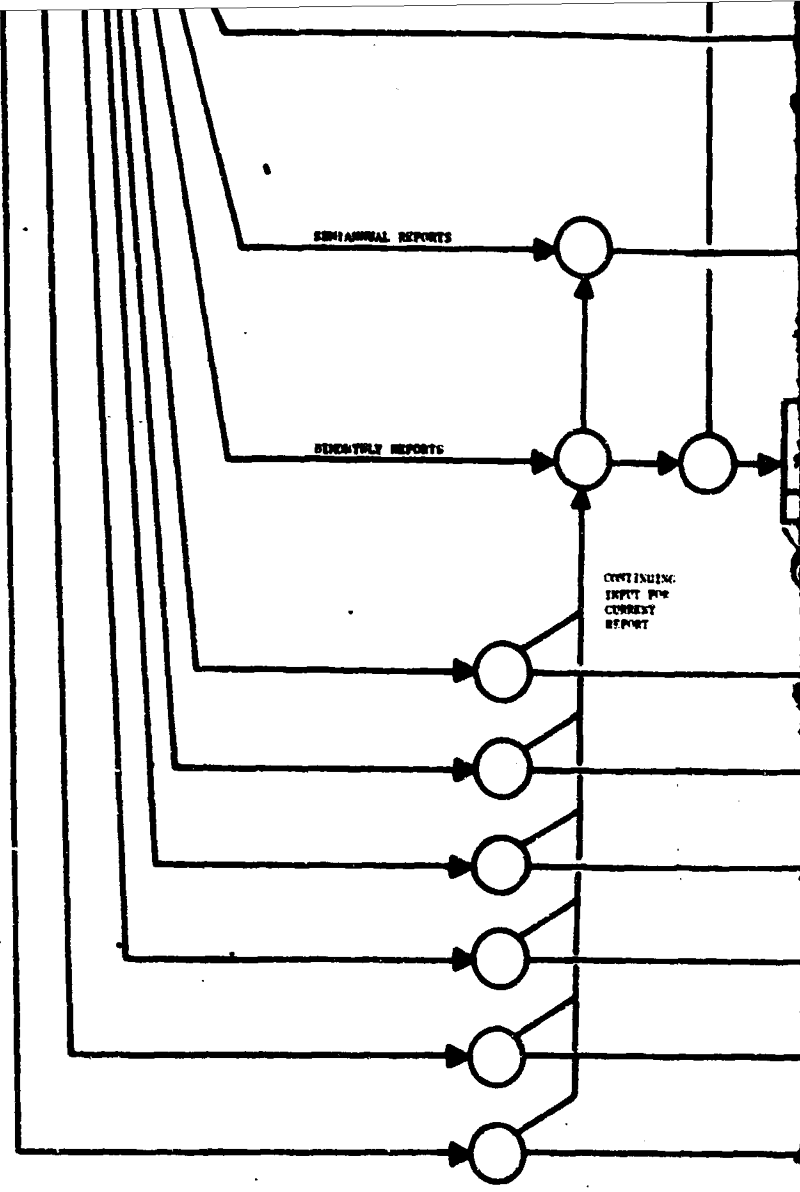

FAILURE MODE
AND EFFECT
ANALYSIS REPORT
C
7-70
FMEA ANALYSIS
CONTINUE RELIABILITY APPORTIONMENT
CONTINUE MATHEMATICAL MODEL
FAILURE DATA
SUMMARY
71
C
6-70
FAILURE DATA
SUMMARY
C
8-70
COMPLETE
SUSTAINING
100-HOUR
FLIGHT TEST
C
9-15-70
SEMI-ANNUAL
REPORT
49
C
7-70
PHASE III
RELIABILITY
REPORT
C
10-70
BIMONTHLY
REPORT
C
BIMONTHLY
REPORT
C
4-70

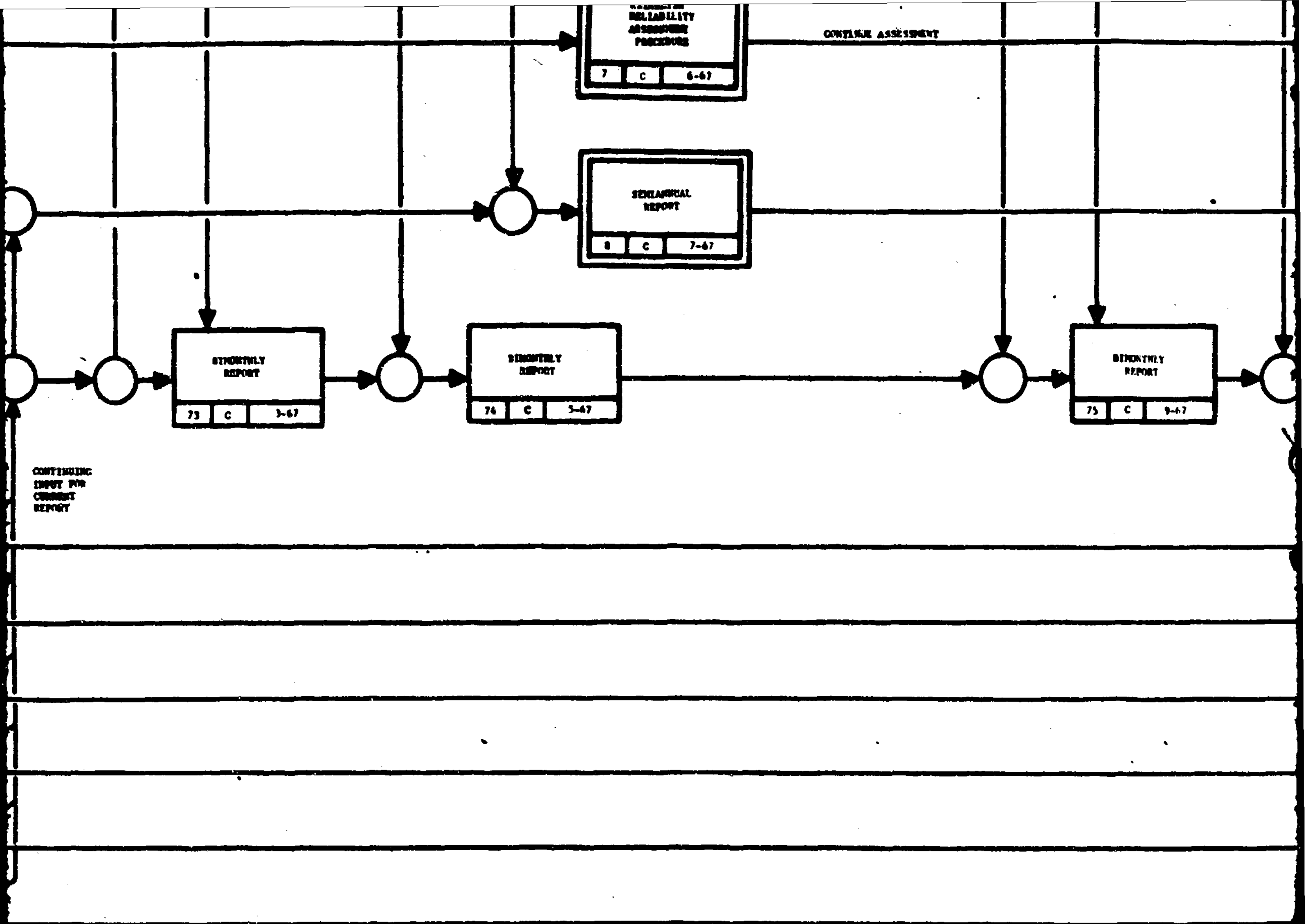
Figure 4.

8


FMEA ANALYSIS
CONTINUE RELIABILITY APPORTIONMENT
CONTINUE MATHEMATICAL MODEL
FAILURE DATA SUMMARY
C 8-70
COMPLETE SUSTAINING ENGINEERING 100-HOUR FLIGHT TEST
88 C 9-15-70
1.06
ENGINE CERTIFICATION
90 C 12-31-71
PHASE III RELIABILITY REPORT
C 10-70
BIMONTHLY REPORT
87 C 4-70



Event Number	Description and Criteria
1	**START PHASE III** Start of Phase III. Phase III go-ahead received from FAA.
2	**RELIABILITY BLOCK DIAGRAM** Diagrams showing logical relation of parts in a component, components in a subsystem, and subsystems in the JTF17. Updated to reflect latest design. Issue block diagrams.
3	**FAILURE MODE AND EFFECT ANALYSIS** An analysis of all potential failure modes of all JTF17 components and parts shown on the reliability block diagrams, event 2, considering a single failure at a time. Includes; failure effects on subsystem, engine and aircraft, method of detection, crew action required, design philosophy to preclude failure, hazard classification and design criteria to reduce hazard. Failure mode and effect analysis is updated each time block diagrams are updated and at least every six months. Current failure mode and effect analysis is dependent on issuance of current block diagrams (event 2). Successful accomplishment of this edition is determined by completion of analysis.
4	**RELIABILITY APPORTIONMENT** Partitioning or apportioning the overall JTF17 reliability goals among the JTF17 subsystems and parts, as shown on the reliability block diagram, event 2. Requires updating as program progresses if more effort is required on a subsystem. Apportionment is subject to completion of reliability block diagram (event 2). Accomplishment is denoted by issuance of the apportioned subsystem and engine reliability goals (failures/1000 hours).
5	**MATHEMATICAL MODEL** A computer program which apportions the reliability requirement of a system to the components and subsystems. The apportionment is based on the probability of component failure and conditional failure of mission due to component failure.
5	**MATHEMATICAL MODEL (Continued)** 1. Failure mode and effect analysis must be completed previously (event 3). 2. Reliability apportionment must be completed previously (event 4). 3. Mathematical model is complete when criticality listing is published.
6	**FAILURE MODE AND EFFECT ANALYSIS REPORT** Issuance of failure mode and effect analysis report. Issuance of report.
7	**ESTABLISH RELIABILITY ASSESSMENT PROCEDURE** Establish ground rules and procedures acceptable to management and Federal Aviation Authority for the evaluation of reliability parameters, such as mean time between failures (MTBF), premature engine removal (PER), etc. Publish reliability assessment procedure.
8	**SEMIANNUAL RELIABILITY REPORT** Reliability progress report to date (through June 1967). Issue report.
9	**RELIABILITY BLOCK DIAGRAM** Diagrams showing logical relation of parts in a component, components in a subsystem, and subsystems in the JTF17. Updated to reflect latest design.
10	**FAILURE MODE AND EFFECT ANALYSIS** An analysis of all potential failure modes of all JTF17 components and parts shown on the reliability block diagrams, event 9, considering a single failure at a time. Includes; failure effects on subsystem, engine and aircraft, method of detection, crew action required, design philosophy to preclude failure, hazard classification and design criteria to reduce hazard. Failure mode and effect analysis is updated each time block diagrams are updated and at least every six months. Current failure mode and effect analysis is dependent on issuance of current block diagram (event 9). Successful accomplishment of particular edition is determined by completion of analysis.



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Event Number	Description and Criteria
11	**RELIABILITY APPORTIONMENT** Partitioning or apportioning the overall JTF17 reliability goals among the JTF17 subsystems and parts, as shown on the reliability block diagram, event 9. Requires updating as program progresses if more effort is required on a subsystem. Apportionment is subject to completion of reliability block diagram (event 9). Accomplishment is denoted by issuance of the apportioned subsystem and engine reliability goals (failures/1000 hours).
12	**MATHEMATICAL MODEL** Computer program which apportions the reliability requirement of a system to the components and subsystems. The apportionment is based on the probability of component failure and conditional failure of mission due to component failure. 1. Failure mode and effect analysis must be completed previously (event 10). 2. Reliability apportionment must be completed previously (event 11). 3. Mathematical model is complete when criticality listing is published.
13	**FAILURE MODE AND EFFECT ANALYSIS REPORT** Issuance of failure mode and effect analysis report. Issuance of report. Event 10 must be completed prior to report being prepared.
14	**SEMIANNUAL RELIABILITY REPORT** Reliability progress report to date (through 1967). Issue report.
15	**RELIABILITY BLOCK DIAGRAM** Diagrams showing logical relation of parts in a component, components in a subsystem, and subsystems in the JTF17. The diagrams are updated to reflect latest design. Issue block diagrams.

Event Number	Description and Criteria
16	**FAILURE MODE AND EFFECT ANALYSIS** An analysis of all potential failure modes of all JTF17 components and parts shown on the reliability block diagrams, event 15, considering a single failure at a time. Includes; failure effects on subsystem, engine and aircraft, method of detection, crew action required, design philosophy to preclude failure, hazard classification and design criteria to reduce hazard. Failure mode and effect analysis is updated each time block diagrams are updated and at least every six months. Current failure mode and effect analysis is dependent on issuance of current block diagrams, event 15. Successful accomplishment of particular edition is determined by completion of analysis.
17	**RELIABILITY APPORTIONMENT** Partitioning or apportioning the overall JTF17 reliability goals among the JTF17 subsystems and parts, as shown on the reliability block diagram, event 15. Requires updating as program progresses if more effort is required on a subsystem. Apportionment is subject to completion of reliability block diagram (event 15). Accomplishment is denoted by issuance of the apportioned subsystem and engine reliability goals (failures/1000 hours).
18	**MATHEMATICAL MODEL** A computer program which apportions the reliability requirement of a system to the components and subsystems. The apportionment is based on the probability of component failure and conditional failure of mission due to component failure. 1. Failure mode and effect analysis must be completed previously (event 16). 2. Reliability apportionment must be completed previously (event 17). 3. Mathematical model is complete when criticality listing is published.

Event Number	
19	RELIABILI Reliabili at test a a reliab trols at Project Completi from SST ability final re
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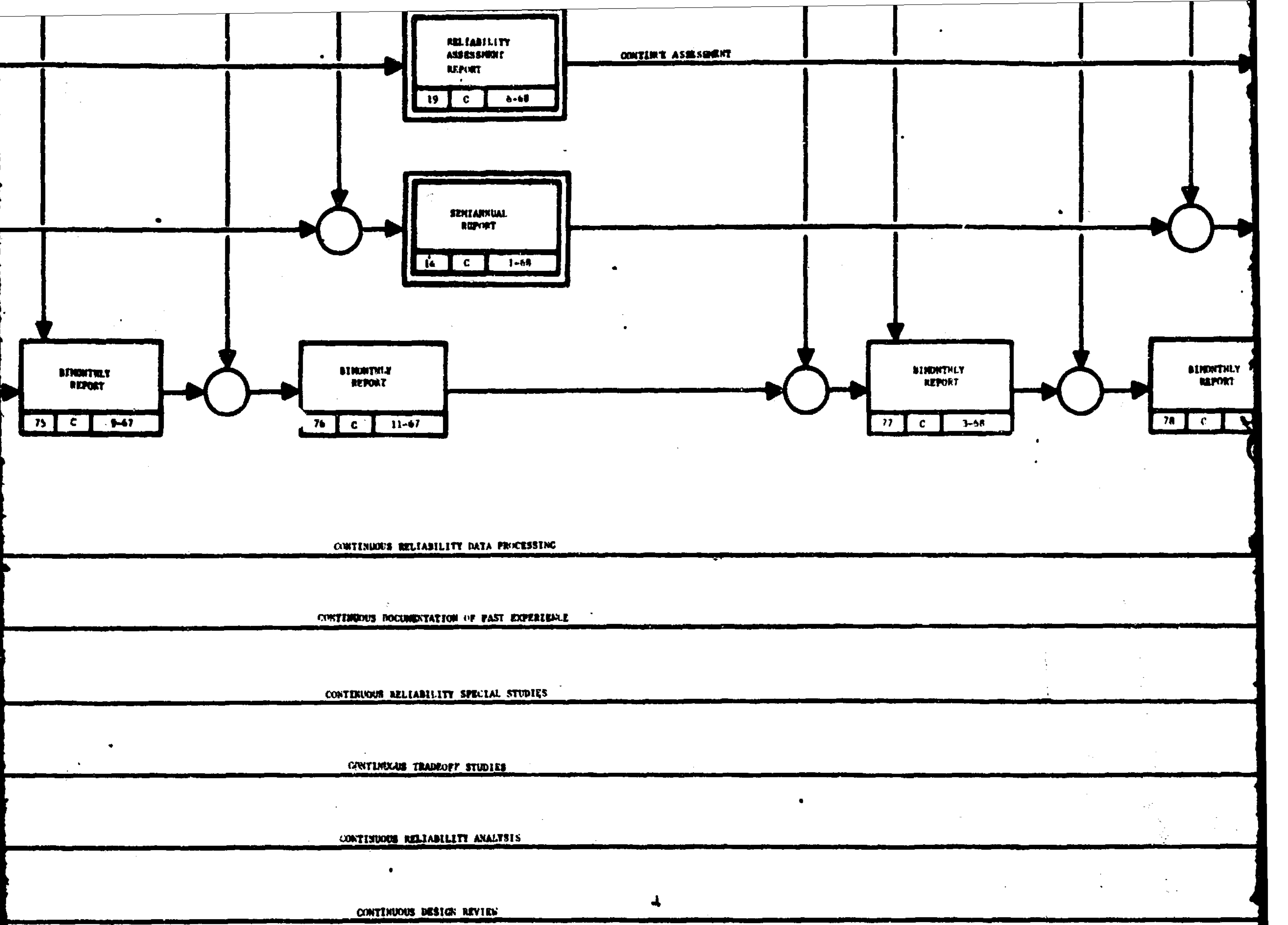
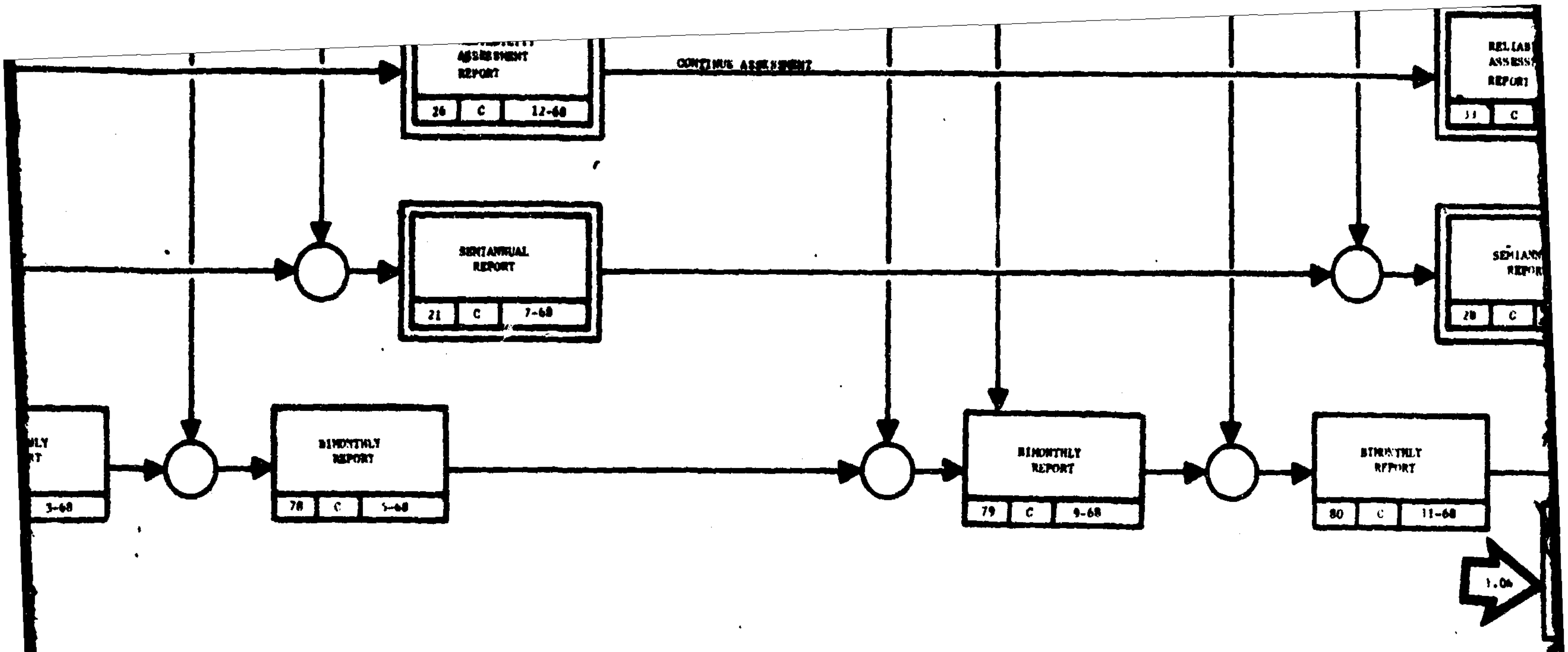


Event Number	Description and Criteria
19	**RELIABILITY ASSESSMENT** Reliability assessment to date of the engine at test and of the test facilities. This is a reliability index of the engine and controls at flight. The input is from SST Project Group. Completion of semiannual assessment. Input from SST Project must be complete. Reliability assessment procedure must be finalized (event 7).
20	**FAILURE MODE AND EFFECT ANALYSIS REPORT** Issuance of failure mode and effect analysis report. Issue report. Event 16 must be completed prior to report being prepared.
21	**SEMIANNUAL RELIABILITY REPORT** Reliability progress report to date. Issue report.
22	**RELIABILITY BLOCK DIAGRAM** Diagrams showing logical relation of parts in a component, components in a subsystem, and subsystems in the JTF17. Block diagrams are updated to reflect latest design. Issue block diagrams.
23	**FAILURE MODE AND EFFECT ANALYSIS** An analysis of all potential failure modes of all JTF17 components and parts shown on the reliability block diagrams, event 22, considering a single failure at a time. Includes, failure effects on subsystem, engine and aircraft, method of detection, crew action required, design philosophy to preclude failure, hazard classification and design criteria to reduce hazard. Failure mode and effect analysis are updated each time block diagrams are updated and at least every six months. Current failure mode and effect analysis is dependent on issuance of current block diagrams, event 22. Successful accomplishment of particular edition is determined by completion of analysis.
24	**RELIABILITY APPORTIONMENT** Partitioning or apportioning the overall JTF17 reliability goals among the JTF17 subsystems and parts, as shown on the reliability block diagram, event 22. Requires updating as program progresses if more effort is required on a subsystem. Apportionment is subject to completion of reliability block diagram (event 22). Accomplishment is denoted by issuance of the apportioned subsystem and engine reliability goals (failures/1000 hours).
25	**MATHEMATICAL MODEL** A computer program which apportions the reliability requirement of a system to the components and subsystems. The apportionment is based on the probability of component failure and conditional failure of mission due to component failure. 1. Failure mode and effect analysis must be completed previously (event 23). 2. Reliability apportionment must be completed previously (event 24). 3. Mathematical model is complete when criticality listing is published.
26	**RELIABILITY ASSESSMENT** Reliability assessment to date of the engine at test and of the test facilities. This is a reliability index of the engine and controls at flight. The input is from SST Project Group. Criteria for successful accomplishment is completion of semiannual assessment. Input from SST Project must be complete.
27	**FAILURE MODE AND EFFECT ANALYSIS REPORT** Issua[illegible] of failure mode and effect analysis rep[illegible] Issue of report is criteria for accomplishment. Event 23 must be completed prior to report being prepared.
28	**SEMIANNUAL RELIABILITY REPORT** Reliability progress report to date. Issue report.
29	**RELIABILITY BLOCK DIAGRAM** Diagrams showing logical relation of par[illegible] in a component, components in a subsystem[illegible] and subsystems in the JTF17, which are [illegible] dated to reflect latest design. Issuance of block diagrams is dependent [illegible] current design being finalized.
30	**FAILURE MODE AND EFFECT ANALYSIS** An analysis of all potential failure mo[illegible] of all JTF17 components and parts shown [illegible] the reliability block diagrams, event 29, considering a single failure at a time. Includes; failure effects on subsystem, engine and aircraft, method of detection, crew action required, design philosophy to preclude failure, hazard classificatio[illegible] and design criteria to reduce hazard. Analysis is updated each time block diag[illegible] are updated and at least every six months. Current failure mode and effect analysis is dependent on issuance of current block diagrams, event 29. Successful accompli[illegible] ment of particular edition is determined by completion of analysis.
31	**RELIABILITY APPORTIONMENT** Partitioning or apportioning the overall reliability goals among the JTF17 subsyst[illegible] and parts, as shown on the reliability bl[illegible] diagram, event 29. Requires updating as program progresses if more effort is requ[illegible] on a subsystem. Apportionment is subject to completion of reliability block diagram (event 29). Accomplishment is denoted by issuance of the apportioned subsystem and engine reliability goals (failures/1000 hours).



EVENT DICTIONARY
2.03 RELIABILITY

Description and Criteria	Event Number

SEMIANNUAL RELIABILITY REPORT 32
Reliability progress report to date.
Issue report.

RELIABILITY BLOCK DIAGRAM
Diagrams showing logical relation of parts in a component, components in a subsystem, and subsystems in the JTF17, which are updated to reflect latest design.
Issuance of block diagrams is dependent on current design being finalized.

FAILURE MODE AND EFFECT ANALYSIS
An analysis of all potential failure modes of all JTF17 components and parts shown on 33
the reliability block diagrams, event 29, considering a single failure at a time. Includes; failure effects on subsystem, engine and aircraft, method of detection, crew action required, design philosophy to preclude failure, hazard classification and design criteria to reduce hazard. Analysis is updated each time block diagrams are updated and at least every six months.
Current failure mode and effect analysis 34
is dependent on issuance of current block diagrams, event 29. Successful accomplishment of particular edition is determined by completion of analysis.

RELIABILITY APPORTIONMENT
Partitioning or apportioning the overall JTF17 35
reliability goals among the JTF17 subsystems and parts, as shown on the reliability block diagram, event 29. Requires updating as program progresses if more effort is required
on a subsystem. 36
Apportionment is subject to completion of reliability block diagram (event 29).
Accomplishment is denoted by issuance of the apportioned subsystem and engine reliability goals (failures/1000 hours).

Description and Criteria	Event Number

MATHEMATICAL MODEL 37
A computer program which apportions the reliability requirement of a system to the components and subsystems. The apportionment is based on the probability of component failure and conditional failure of mission due to component failure.

1. Failure mode and effect analysis must be completed previously (event 30).
2. Reliability apportionment must be completed previously (event 31).
3. Mathematical model is complete when criticality listing is published.

RELIABILITY ASSESSMENT
Reliability assessment to date of the engine at test and of the test facilities. This is a reliability index of the engine and
controls at flight. The input is from SST 38
Project Group.
Completion of semiannual assessment is criteria. Input from SST Project must be complete.

FAILURE MODE AND EFFECT ANALYSIS REPORT
Issuance of failure mode and effect anlaysis report.
Criteria is issuance of report. Event 30 must be completed prior to report being prepared.

SEMIANNUAL RELIABILITY REPORT 39
This report is the reliability progress report to date.
Issue report.

RELIABILITY BLOCK DIAGRAM
Diagrams showing logical relation of parts in a component, components in a subsystem, and subsystems in the JTF17, updated to reflect latest design.
Issue block diagrams.

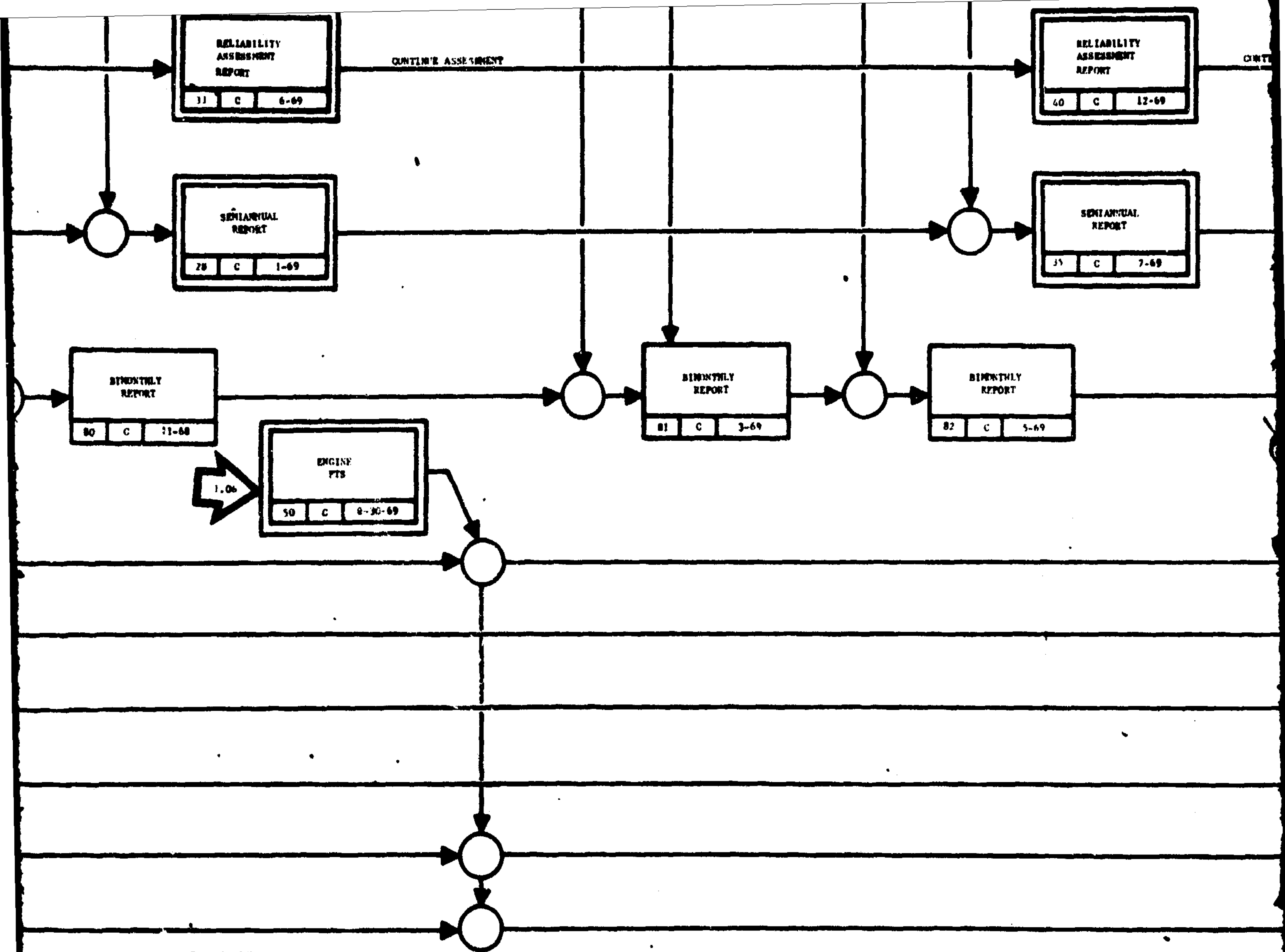
Description and Criteria	Event Number

FAILURE MODE AND EFFECT ANALYSIS 40
An analysis of all potential failure modes of all JTF17 components and parts shown on reliability block diagrams, event 36, considering a single failure at a time. Includes; failure effects on subsystem, engine and aircraft, method of detection, crew action required, design philosophy to preclude failure, hazard classification
and design criteria to reduce hazard. 41
Analysis is updated each time block diagrams are updated and at least every six months.
Current failure mode and effect analysis is dependent on issuance of current block diagrams, event 36. Successful accomplish-
ment of particular edition is determined 42
by completion of analysis.

RELIABILITY APPORTIONMENT
Partitioning or apportioning the overall
JTF17 reliability goals among the JTF17 43
subsystems and parts, as shown on the reliability block diagram, event 36. Requires updating as program progresses if more effort is required on a subsystem.
Apportionment is subject to completion of reliability block diagram (event 36).
Accomplishment is denoted by issuance of
the apportioned subsystem and engine 44
reliability goals (failures/1000 hours).

MATHEMATICAL MODEL
A computer program which apportions the reliability requirement of a system to the components and subsystems. The apportionment is based on the probability of component failure and conditional failure of mission due to component failure.

1. Failure mode and effect analysis must be completed previously (event 37).
2. Reliability apportionment must be completed previously (event 38).
3. Mathematical model is complete when criticality listing is published.



EVENT DICTIONARY
2.01 RELIABILITY

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...apportioning the overall ...y goals among the JTF17 ...arts, as shown on the ...k diagram, event 36. Re... ...s program progresses if ...quired on a subsystem. ...subject to completion of ...k diagram (event 36). ...noted by issuance of ...ubsystem and engine ...s (failures/1000 hours).

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...m which apportions the ...irement of a system to the ...ubsystems. The apportion... ...the probability of com... ...al conditional failure of ...mponent failure. ...and effect analysis must be ...iously (event 37). ...portionment must be com... ...sly (event 38). ...model is complete when ...ting is published.

Event Number

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Description and Criteria

RELIABILITY ASSESSMENT
Reliability assessment to date of the engine at test and of the test facilities. This is a reliability index of the engine and controls at flight. The input is from SST Project Group.
Criteria is completion of semiannual assessment. Input from SST Project must be complete.

FAILURE MODE AND EFFECT ANALYSIS REPORT
Issue failure mode and effect analysis report.
Issue report. Event 37 must be completed prior to report being prepared.

SEMIANNUAL RELIABILITY REPORT
This is the reliability progress report to date.
Issue report.

RELIABILITY BLOCK DIAGRAM
Diagrams showing logical relation of parts in a component, components in a subsystem, and subsystems in the JTF17, updated to reflect latest design
Issuance of block diagrams is dependent on current design being finalized.

FAILURE MODE AND EFFECT ANALYSIS
An analysis of all potential failure modes of all JTF17 components and parts shown on the reliability block diagrams, event 43, considering a single failure at a time. Includes; failure effects on subsystem, engine and aircraft, method of detection, crew action required, design philosophy to preclude failure, hazard classification and design criteria to reduce hazard. Analysis updated each time block diagrams are updated and at least every six months. Current failure mode and effect analysis is dependent on issuance of current block diagrams (event 43). Successful accomplishment of particular edition is determined by completion of analysis.

Event Number

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Description and Criteria

RELIABILITY APPORTIONMENT
Partitioning or apportioning the overall JTF17 reliability goals among the JTF17 subsystems and parts, as shown on the reliability block diagram, event 43. Requires updating as program progresses if more effort is required on a subsystem. Apportionment is subject to completion of reliability block diagram (event 43). Accomplishment is denoted by issuance of the apportioned subsystem and engine reliability goals (failures/1000 hours).

MATHEMATICAL MODEL
A computer program which apportions the reliability requirement of a system to the components and subsystems. The apportionment is based on the probability of component failure and conditional failure of mission due to component failure.
1. Failure mode and effect analysis must be completed previously (event 44).
2. Reliability apportionment must be completed previously (event 45).
3. Mathematical model is complete when criticality listing is published.

RELIABILITY ASSESSMENT
Reliability assessment to date of the engine at test and of the test facilities. This is a reliability index of the engine and controls at flight. The input is from SST Project Group.
Criteria is completion of semiannual assessment. Input from SST Project must be complete.

FAILURE MODE AND EFFECT ANALYSIS REPORT
Issue of failure mode and effect analysis report.
Issue of report. Event 44 must be completed prior to report being prepared.

SEMIANNUAL RELIABILITY REPORT
This is a report of reliability progress to date.
Issue report.

Event Number

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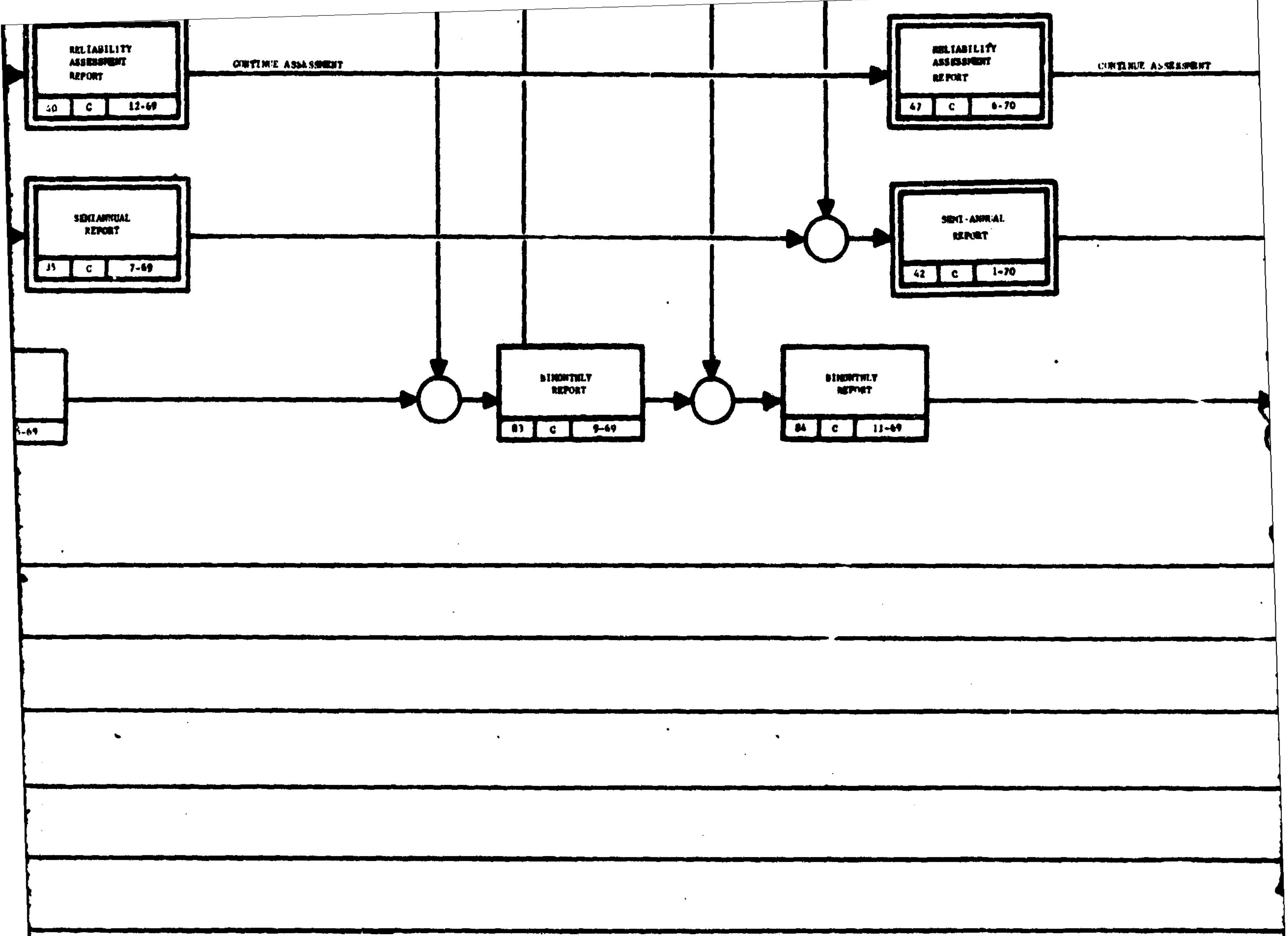

Event Number	Description and Criteria
50	ENGINE FTS Reference engine network 1.06 for description and criteria.
51	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
52	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
53	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
54	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
55	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
56	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
57	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
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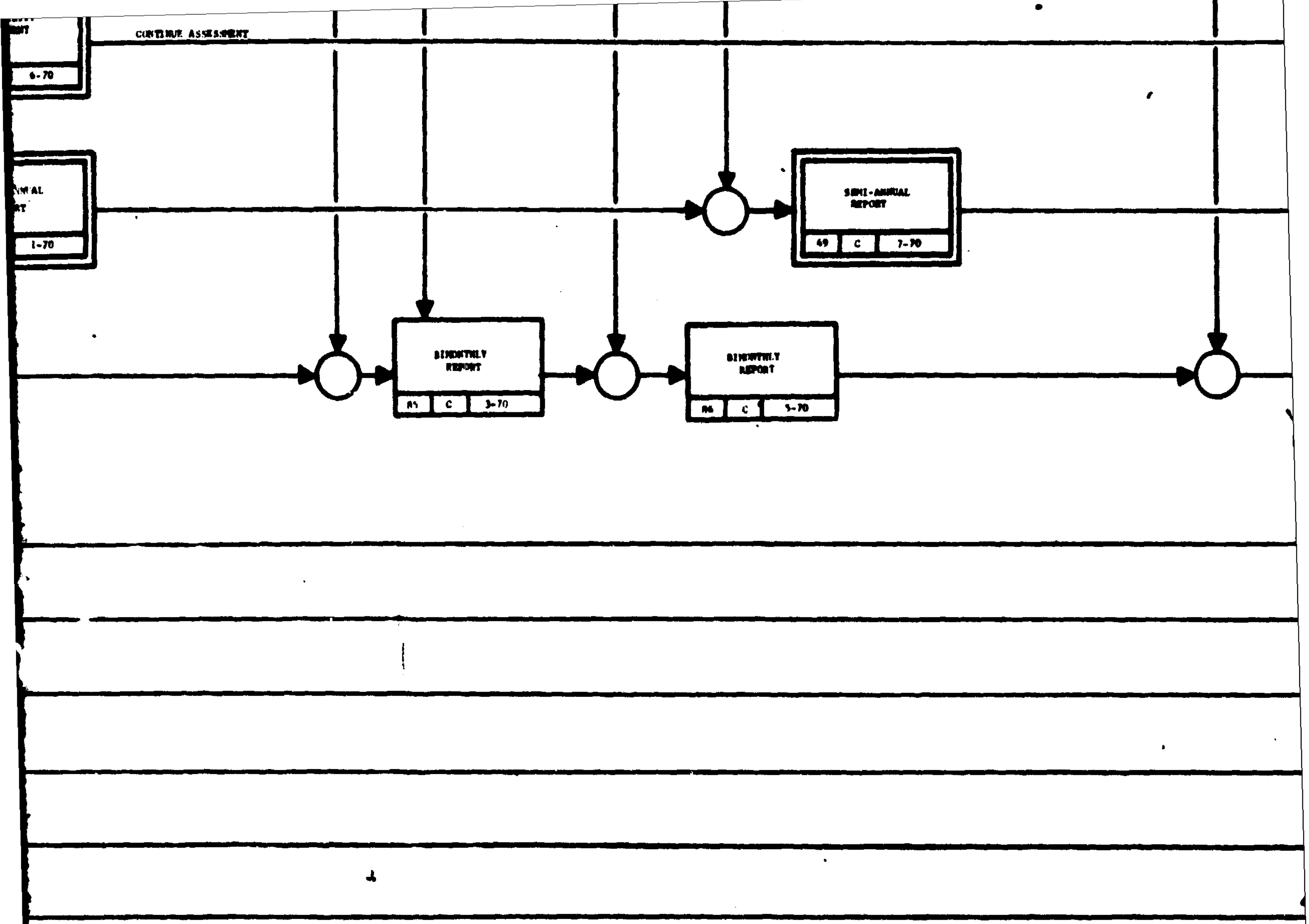
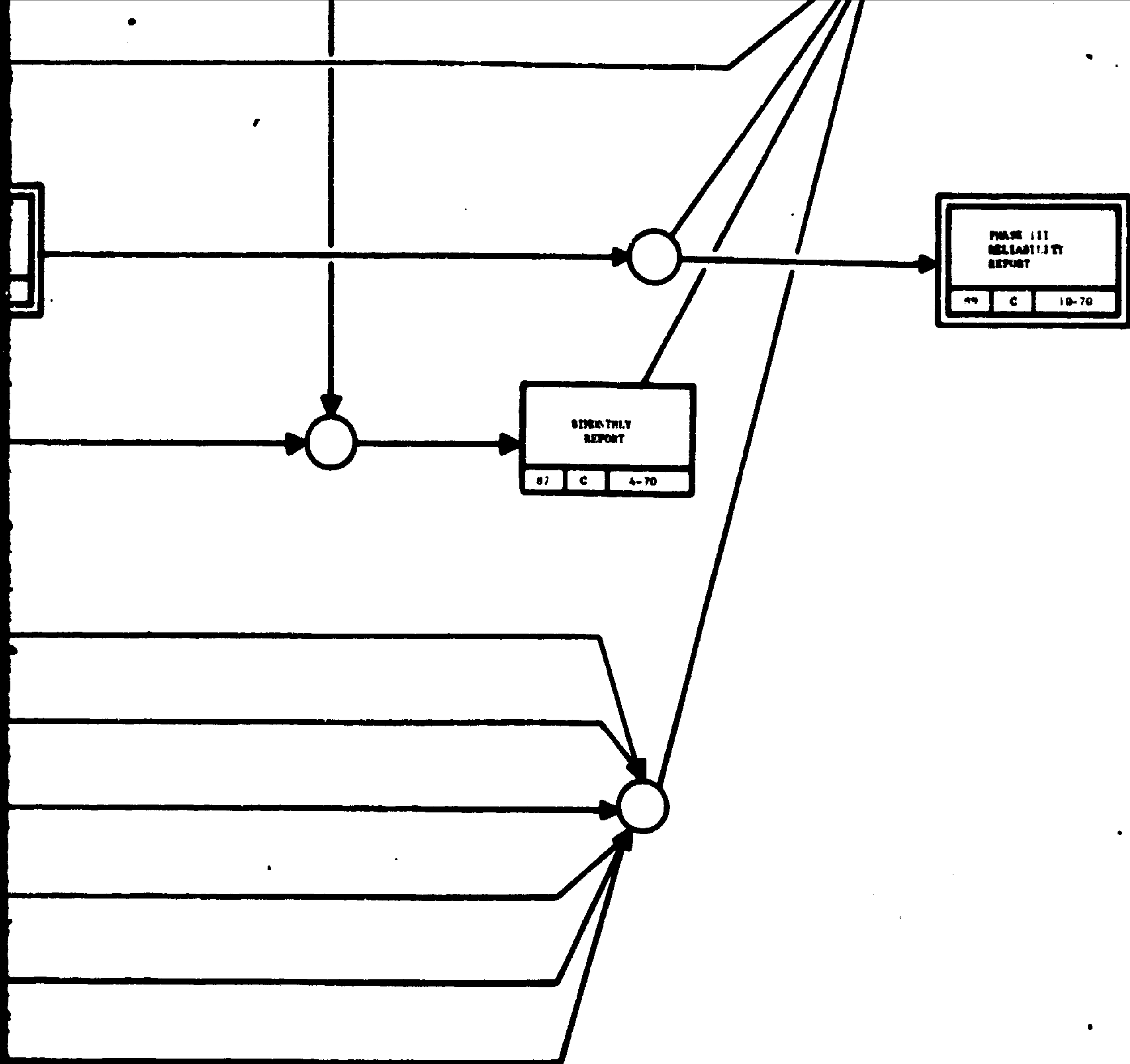
60	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
61	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
62	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
63	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
64	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.
65	FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.



Description and Criteria	Event Number
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	66
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	67
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	68
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	69
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	70

Description and Criteria	Event Number
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failures and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	71
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failure and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	72
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failure and of the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	73 74
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failure and the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	75
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failure and the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	76 77

Description and Criteria	Event Number
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failure and the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	78 79
FAILURE DATA SUMMARY This is a summarization of failures by types, engines, sequence, etc. This includes a description of the failure and the results, such as, unscheduled test termination, failure analysis, part disposition, etc. Issue summary.	80
BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.	81
BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.	82
BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.	83
BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.	84
BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.	85



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Event Number	Description and Criteria
78	BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.
79	BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.
80	BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.
81	BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.
82	BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.
83	BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.
84	BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.
85	BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.

Event Number	Description and Criteria
86	BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.
87	BI-MONTHLY PROGRESS REPORT Issue a bi-monthly reliability progress report in accordance with Phase III Proposal. Issue report.
88	COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST End of Phase III. Completion of 100 hours of flight testing.
89	PHASE III RELIABILITY REPORT This is the final Reliability Report to be issued with the Phase III Final Report. Issue report.
90	ENGINE CERTIFICATION Reference engine network 1.0B for description and criteria.

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2.04 QUALITY ASSURANCE

The Quality Assurance program, described in detail in Volume IV, Report F, Section III, defines the Quality Assurance organizational responsibilities and accomplishments to assure that all quality requirements are incorporated in the engine from initial design through final test. The necessary documents to establish the requirements and guarantee compliance are a part of the program.

Quality Assurance is closely associated with scheduling of individual parts, assemblies, and completed engines. The time phased requirements will be Quality Assurance Data Sheets (QADS), Inspection Methods Sheets (IMS), Engine History Record Sheets (EHRS) and special inspection tooling. The time schedule for each part and assembly varies throughout the engine build cycle and therefore no single time phased requirement is possible.

The major milestones, network chart and event dictionary for quality assurance are shown in figures 5 and 6, respectively. Test planning and integration of quality assurance is presented in Test, Volume IV, Report E.

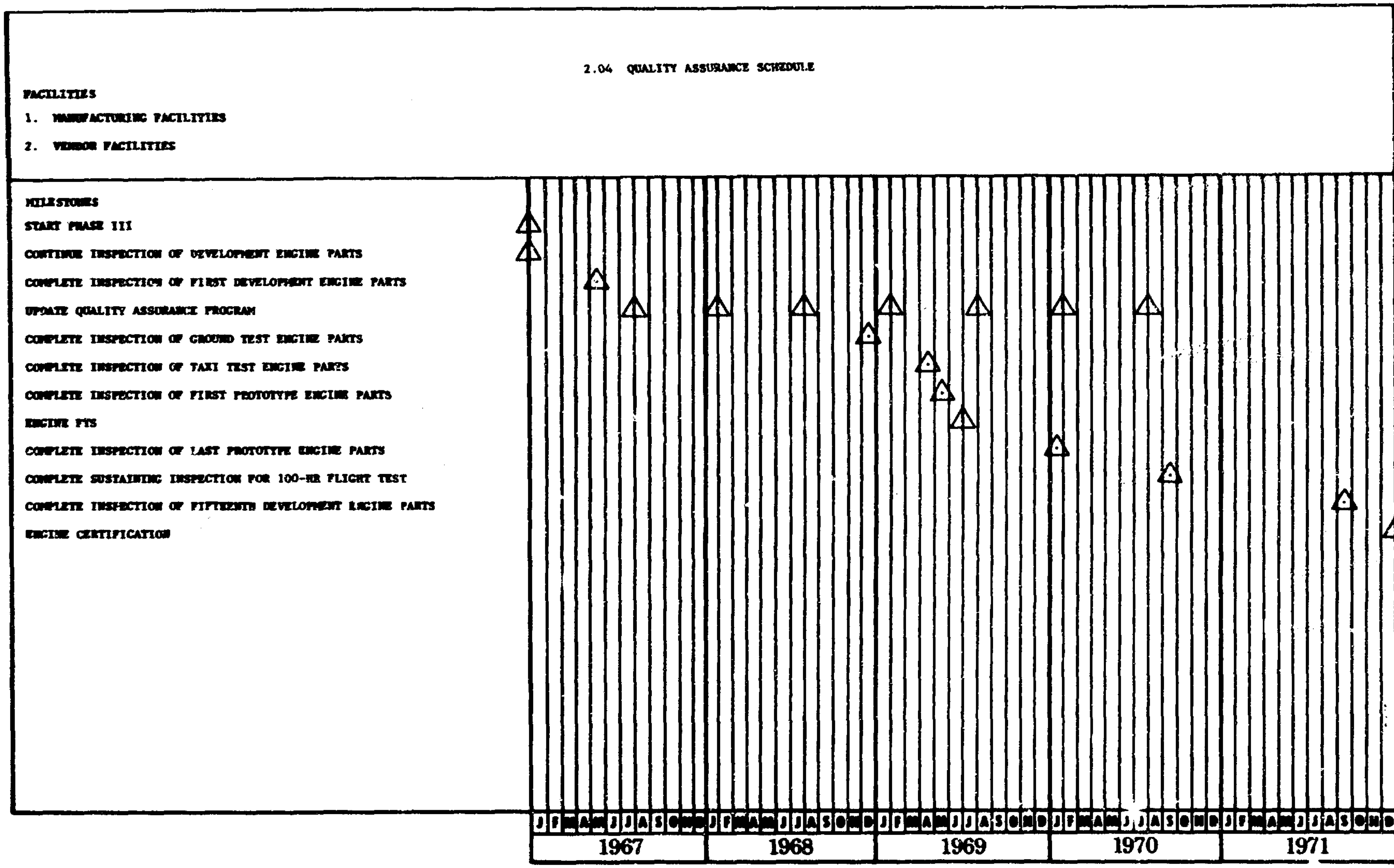

Figure 5. 2.04 Quality Assurance

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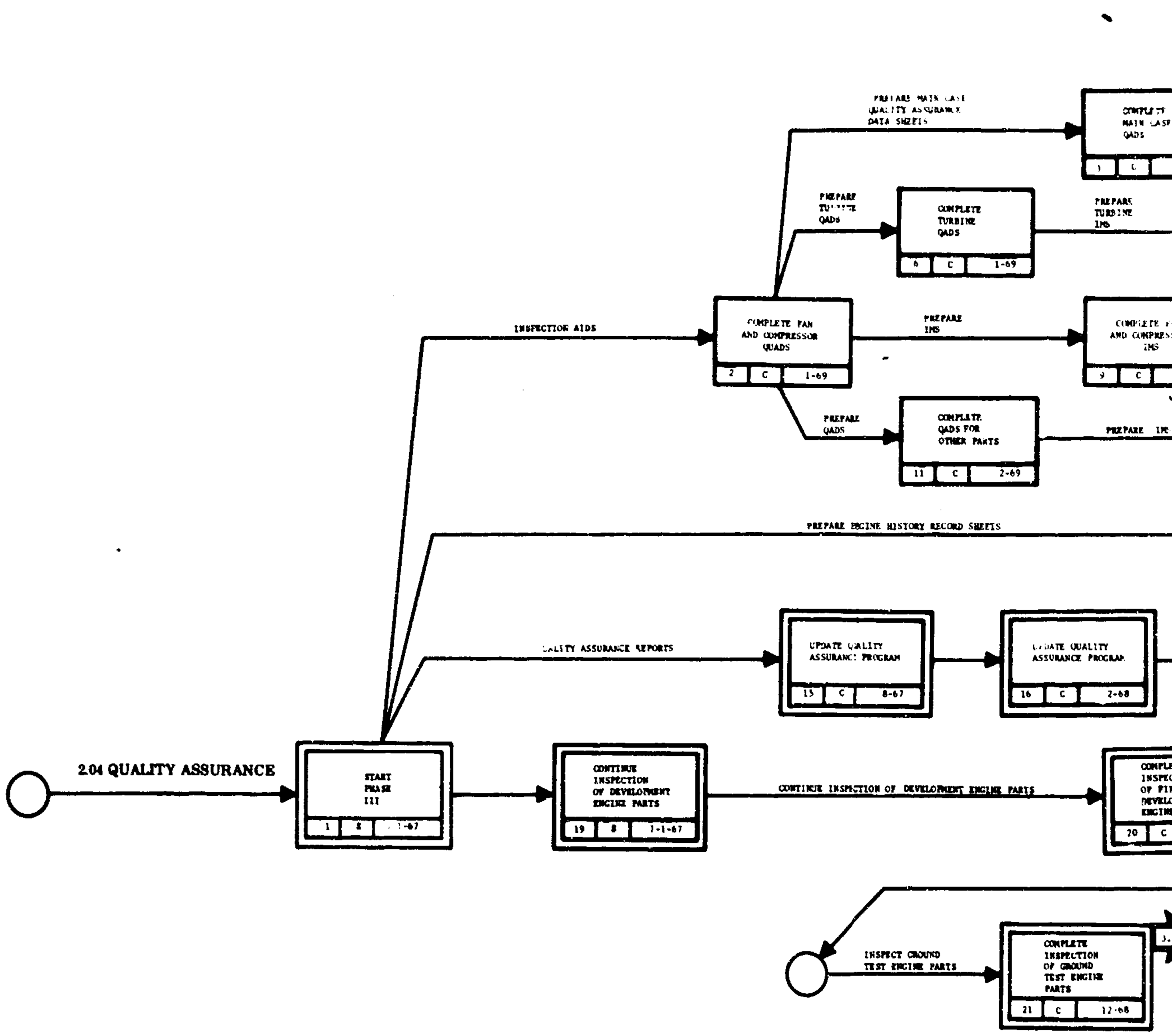
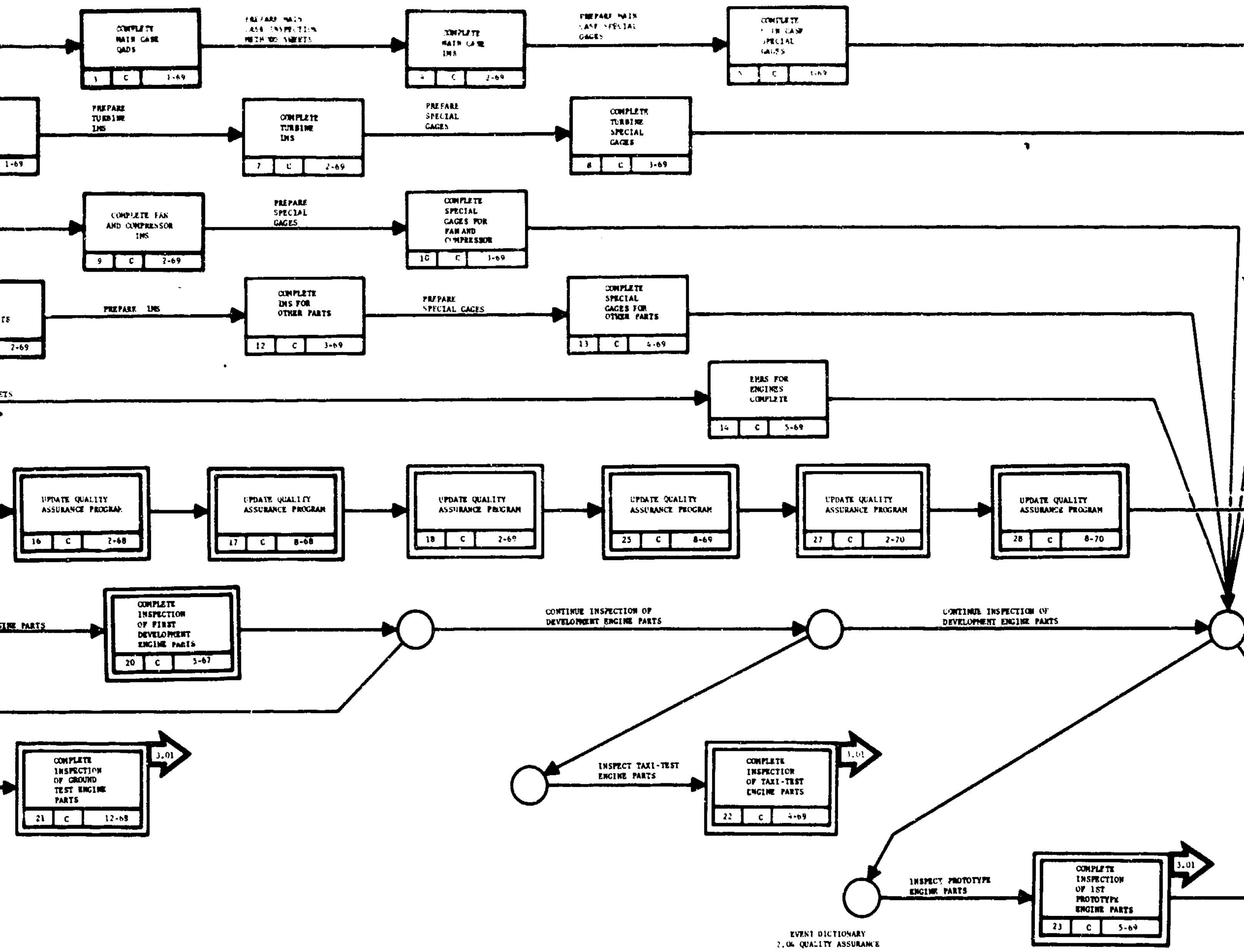


Event Number	Description and Criteria
1	START OF PHASE III Start of Phase III Phase III go-ahead
2	COMPLETE FAN AND COMPRESSOR QADS Complete the preparation of Quality Assurance Data Sheets for JTF17 fan and compressor parts. Issue the QADS.
3	COMPLETE MAIN CASE QADS Complete the preparation of Quality Assurance Data Sheets for JTF17 main cases. Issue the QADS
4	COMPLETE MAIN CASE IMS Complete the preparation of Inspection Methods Sheets for JTF17 main cases. Issue the IMS.
5	COMPLETE MAIN CASE SPECIAL GAGES Complete the special gages required for inspection of JTF17 main cases. All special gages available for use.

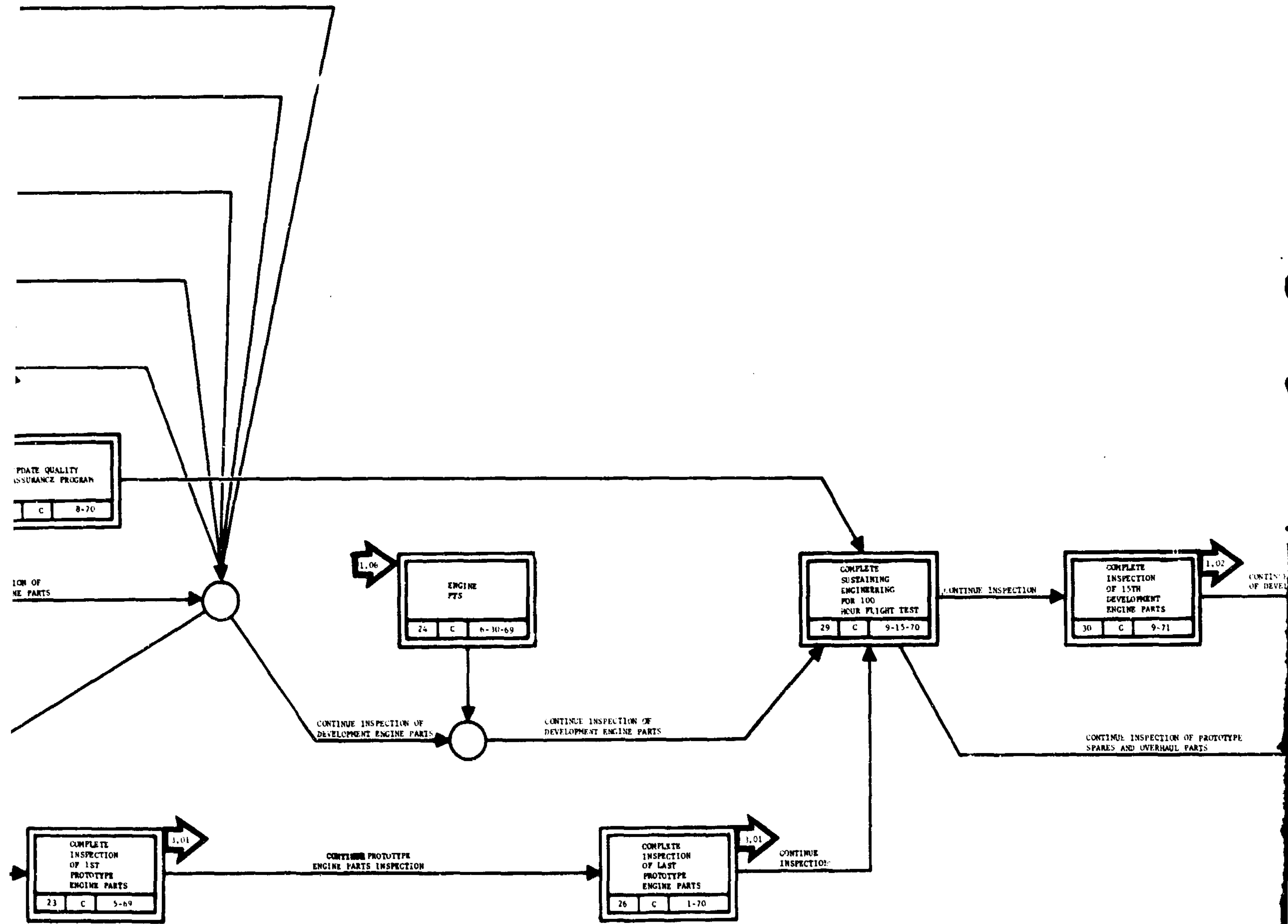
Event Number	
6	COMPLETE TU complete th the QADS.
7	COMPLETE TU Complete th Sheets for
8	COMPLETE TU Complete th of JTF17 tu
9	COMPLETE FA Complete th Sheets for Issue the I
10	COMPLETE SP Complete th of JTF17 ta gages avail

Figure 6. 2.04 Quality Assurance



EVENT DICTIONARY
2.04 QUALITY ASSURANCE

Event Number	Description and Criteria
6	COMPLETE TURBINE QADS Complete the preparation of Quality Assurance Data Sheets for JTF17 turbine parts. Issue the QADS.
7	COMPLETE TURBINE IMS Complete the preparation of Inspection Methods Sheets for JTF17 turbine parts. Issue the IMS.
8	COMPLETE TURBINE SPECIAL GAGES Complete the special gages required for inspection of JTF17 turbine parts.
9	COMPLETE FAN AND COMPRESSOR IMS Complete the preparation of Inspection Methods Sheets for JTF17 fan and compressor parts. Issue the IMS.
10	COMPLETE SPECIAL GAGES FOR FAN AND COMPRESSOR Complete the special gages required for inspection of JTF17 fan and compressor parts. All special gages available for use.
11	COMPLETE QADS FOR OTHER PARTS Complete the preparation of Quality Assurance Data Sheets for other JTF17 engine parts as required. Issue the QADS.
12	COMPLETE IMS FOR OTHER PARTS Complete the preparation of Inspection Methods Sheets for other JTF17 engine parts as required. Issue the IMS.
13	COMPLETE SPECIAL GAGES FOR OTHER PARTS Complete the special gages required for inspection of other JTF17 engine parts as required. All special gages available for use.
14	COMPLETE EHRS FOR ENGINES Complete the preparation of Engine History Record Sheets for the JTF17 engines. Issue the EHRS.
15	UPDATE QUALITY ASSURANCE PROGRAM Make the necessary revisions to update the Quality Assurance program to show accomplishments. Submit the revised program.
16	UPDATE QUALITY ASSURANCE PROGRAM Make the necessary revisions to update the Quality Assurance program to show accomplishments. Submit the revised program.
17	UPDATE QUALITY ASSURANCE PROGRAM Make the necessary revisions to update the Quality Assurance program to show accomplishments. Submit the revised program.
18	UPDATE QUALITY ASSURANCE PROGRAM Make the necessary revisions to update the Quality Assurance program to show accomplishments. Submit the revised program.
19	CONTINUE INSPECTION OF DEVELOPMENT ENGINE PARTS Continue the inspection of engine parts required for the JTF17 engine development program. Phase III go-ahead received from FAA.
20	COMPLETE INSPECTION OF FIRST DEVELOPMENT ENGINE PARTS Complete the inspection of all parts required for the first development engine. Deliver parts to stores or assembly.

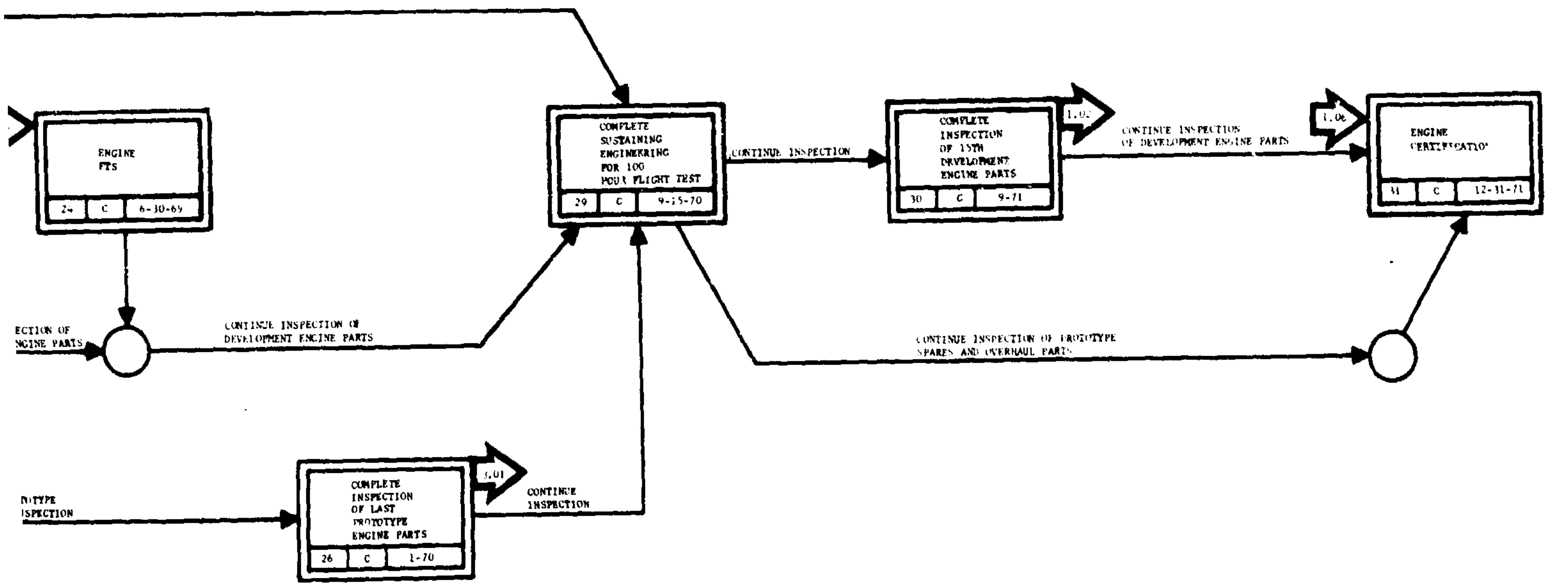


Description and Criteria
ASSURANCE PROGRAM program to show accom lish-
ASSURANCE PROGRAM ary revisions to update the ce program to show accomplish- the revised program.
ASSURANCE PROGRAM ary revisions to update the ce program to show accomplish- the revised program.
TION OF DEVELOPMENT ENGINE PARTS nspection of engine parts required engine development program. head received from FAA.
TION OF FIRST DEVELOPMENT ENGINE nspection of all parts required development engine. Deliver s or assembly.

Event Number	Description and Criteria
21	COMPLETE INSPECTION OF GROUND TEST ENGINE PARTS Complete the inspection of all parts required for the last g engine. Deliver parts to stores or assembly.
22	COMPLETE INSPECTION OF TAXI TEST ENGINE PARTS Complete the inspection of all parts required for the last taxi test engine. Deliver parts to stores or assembly.
23	COMPLETE INSPECTION OF FIRST PROTOTYPE ENGINE PARTS Complete the inspection of all parts required for the first prototype engine. Deliver parts to stores or assembly.
24	ENGINE PTS Reference engine network 1.06 for description and criteria.
25	UPDATE QUALITY ASSURANCE PROGRAM Make the necessary revisions to update the Quality Assurance program to show accomplishments. Submit the revised program.

Event Number	Description and Criteria
26	COMPLETE INSPECTION OF LAST PROTOTYPE ENGINE PARTS te the of all parts required or the last prototype engine. Deliver parts to stores or assembly.
27	UPDATE QUALITY ASSURANCE PROGRAM Make the necessary revisions to update the Quality Assurance program to show accomplishments. Submit the revised program.
28	UPDATE QUALITY ASSURANCE PROGRAM Make the necessary revisions to update the Quality Assurance program to show accomplishments. Submit the revised program.
29	COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST End of Phase III. Completion of 100 hours of flight testing.
30	COMPLETE INSPECTION OF 15TH DEVELOPMENT ENGINE PARTS Complete the inspection of all parts required for the 15th development engine. Deliver parts to stores or assembly.
31	ENGINE CERTIFICATION Reference engine network 1.06 for description and criteria.

3



Description and Criteria

TE INSPECTION OF GROUND TEST ENGINE PARTS
te the inspection of all parts required
last ground test engine. Deliver parts
es or assembly.

E INSPECTION OF TAXI TEST ENGINE PARTS
e the inspection of all parts required
last taxi test engine. Deliver parts
es or assembly.

E INSPECTION OF FIRST PROTOTYPE ENGINE

e the inspection of all parts required
first prototype engine. Deliver parts
es or assembly.

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ce engine network 1.06 for description
teria.

QUALITY ASSURANCE PROGRAM
e necessary revisions to update the quality
ce program to show accomplishments. Submit
ised program

Event Number	Description and Criteria
26	**COMPLETE INSPECTION OF LAST PROTOTYPE ENGINE PARTS** Complete the inspection of all parts required for the last prototype engine. Deliver parts to stores or assembly.
27	**UPDATE QUALITY ASSURANCE PROGRAM** Make the necessary revisions to update the Quality Assurance program to show accomplishments. Submit the revised program.
28	**UPDATE QUALITY ASSURANCE PROGRAM** Make the necessary revisions to update the Quality Assurance program to show accomplishments. Submit the revised program.
29	**COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST** End of Phase III. Completion of 100 hours of flight testing.
30	**COMPLETE INSPECTION OF 15TH DEVELOPMENT ENGINE PARTS** Complete the inspection of all parts required for the 15th development engine. Deliver parts to stores or assembly.
31	**ENGINE CERTIFICATION** Reference engine network 1.06 for description and criteria.

4

2.05 VALUE ENGINEERING

The Value Engineering Program provides function-to-cost evaluation of all aspects of the supersonic transport engine program and is described in detail in Volume IV, Report F, Section IV. This program provides the following:

1. A value engineering director, who controls the integrated value engineering activities and functions.
2. An organization in key departments that utilizes function-oriented methods, procedures, equipment and personnel in a systematic effort to optimize or reduce cost.
3. A review of subcontractor drawings and specifications to ensure integration within the program.
4. A training program to indoctrinate personnel in value engineering.
5. A formal reporting system for documenting savings attributed to the Supersonic Transport Program and assessing progress toward target costs.

The functional approach applies to every department involved in the JTF17 program and, when integrated, provides maximum value from each program dollar.

The major milestones, network chart and event dictionary for value engineering are shown in figures 7 and 8, respectively. Test planning and integration of value engineering is presented in Test, Volume IV, Report E.

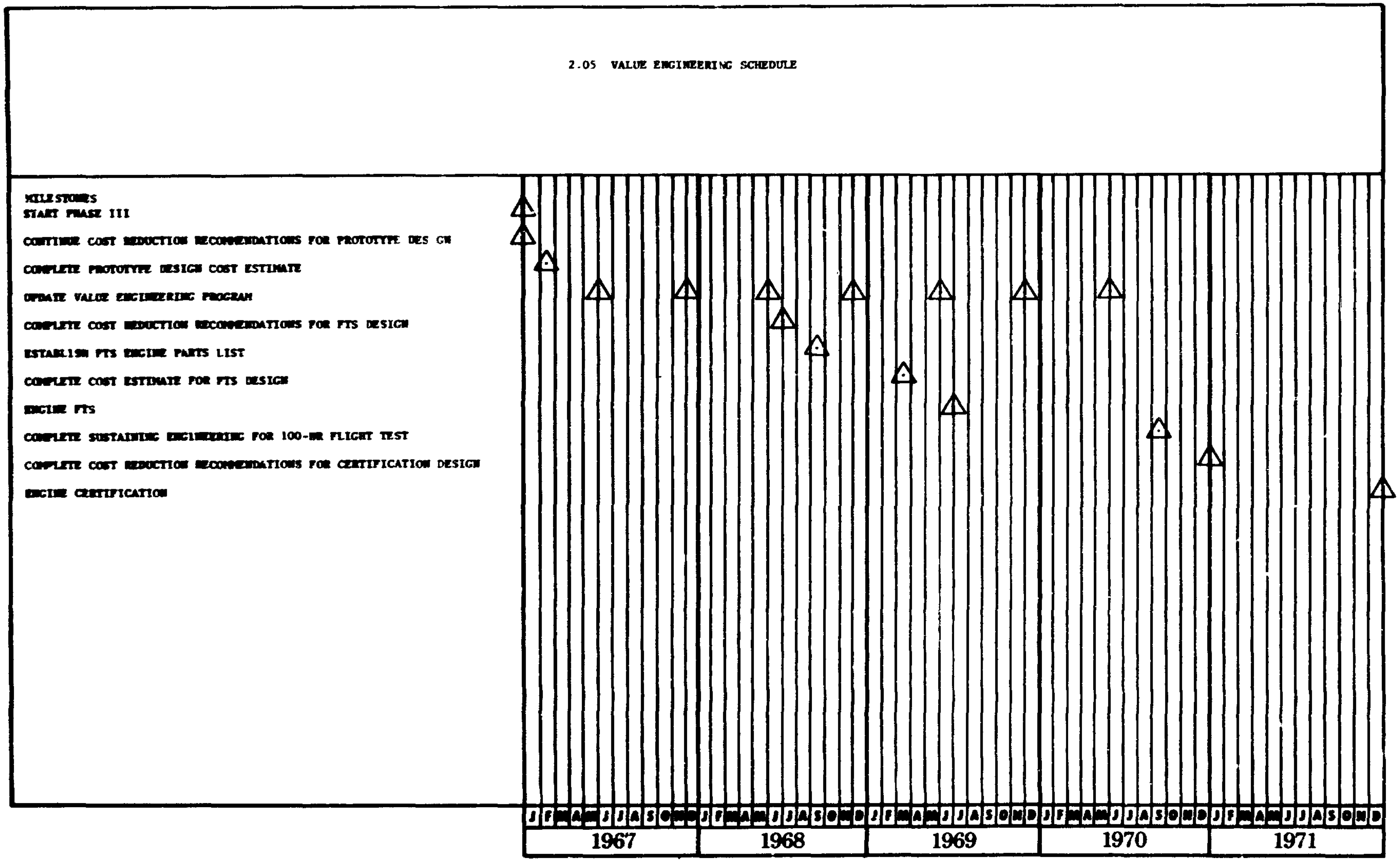

Figure 7. 2.05 Value Engineering

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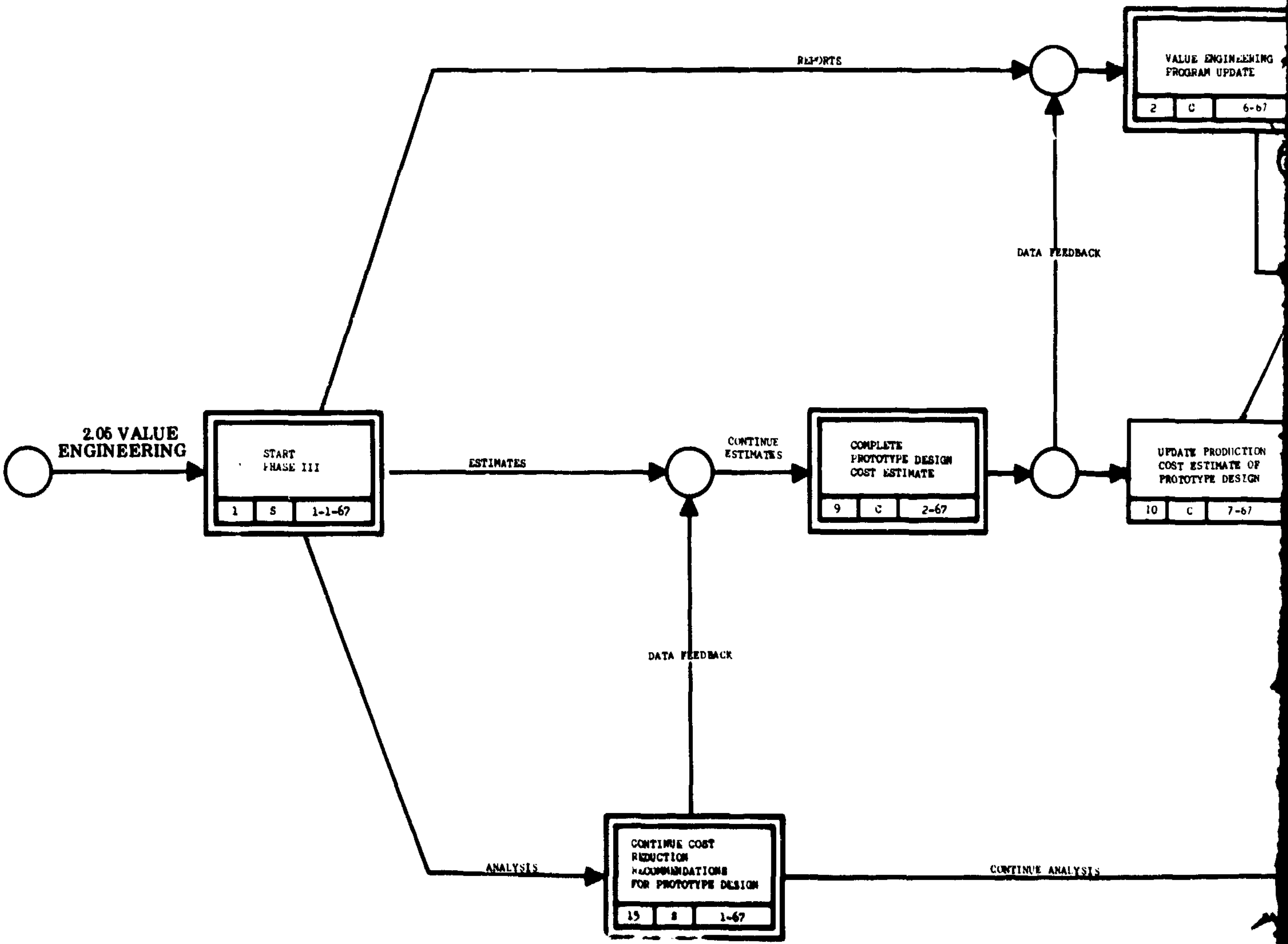
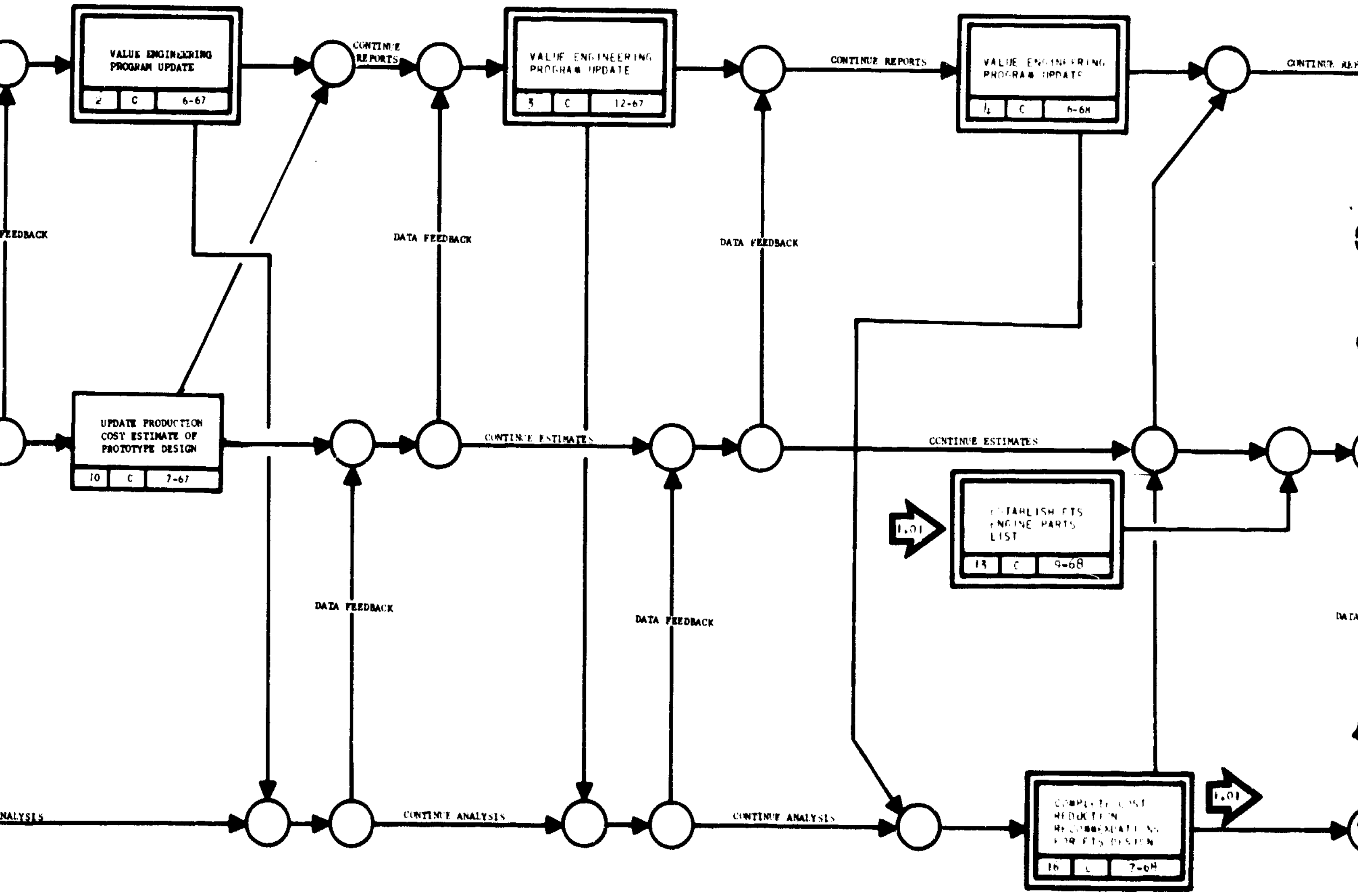
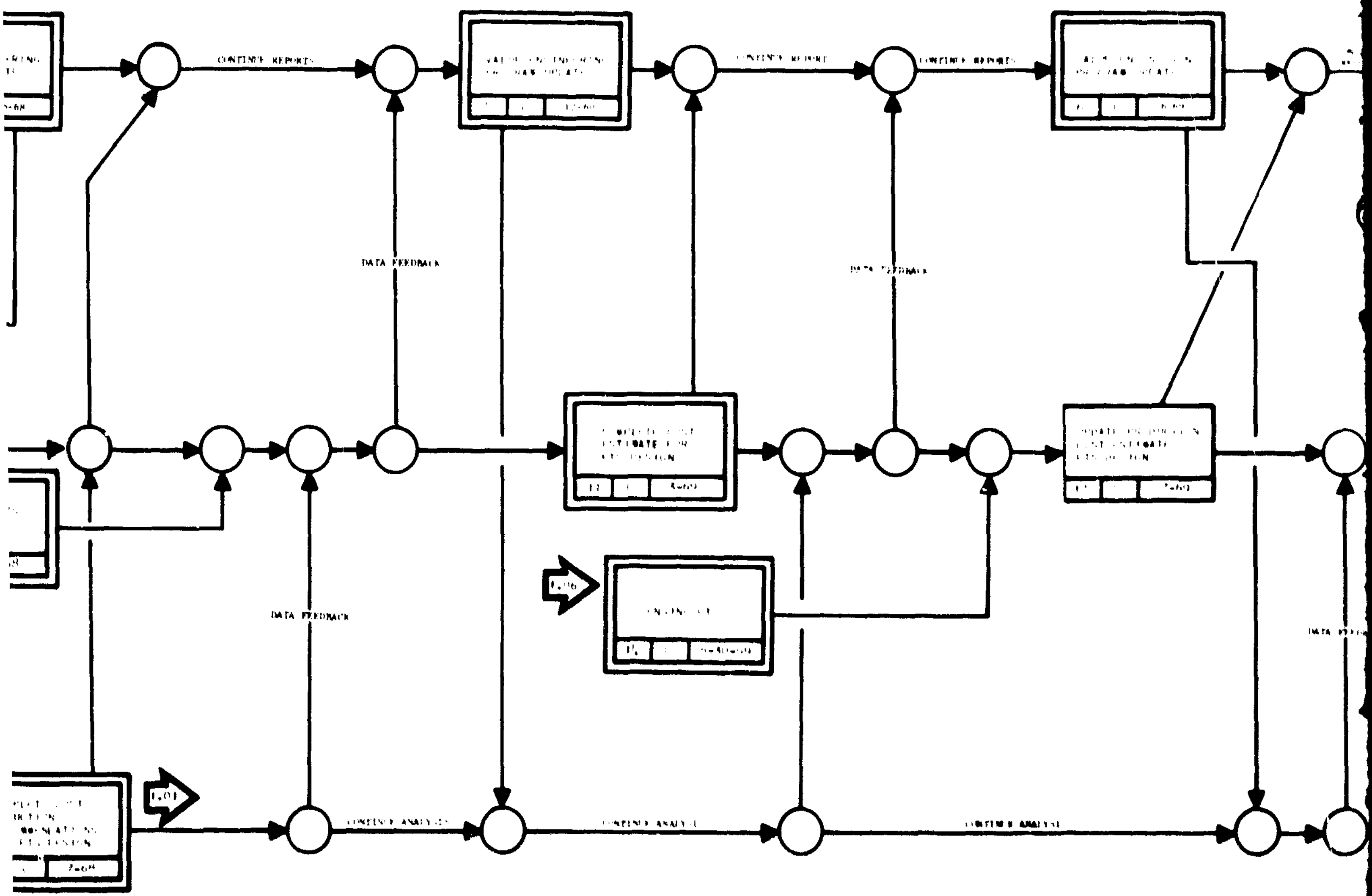


Figure 8. 2.05 Value Engineering

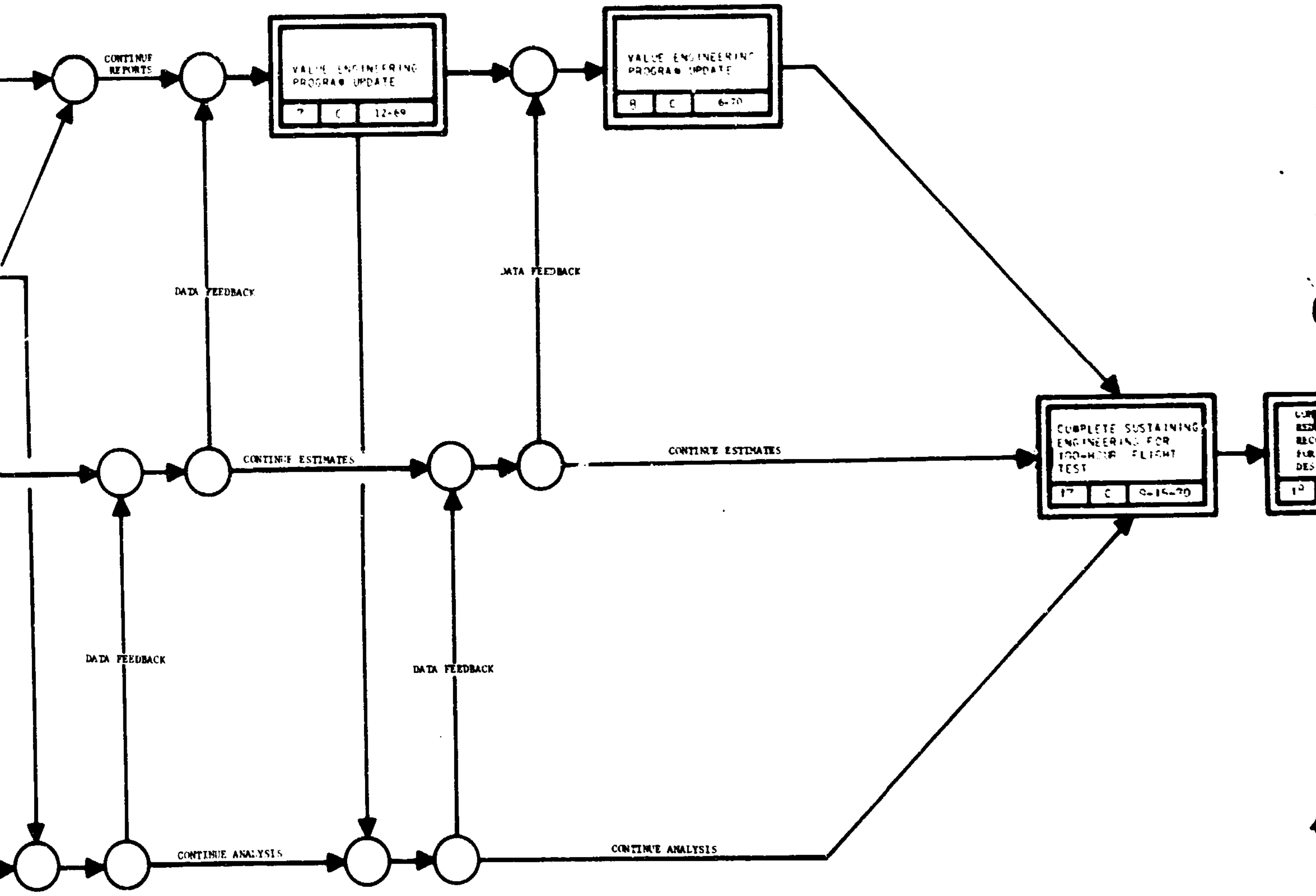


Event Number	Description and Criteria
1	START PHASE III Start of Phase III. Phase III is released as cited from FAA.
2	VALUE ENGINEERING PROGRAM UPDATE Calculate changes to program cost as a result of changes to the engine design and report cost reduction progress. Issuance of report.
3	VALUE ENGINEERING PROGRAM UPDATE Calculate changes to program cost as a result of changes to the engine design and report cost reduction progress. Issuance of report.
4	VALUE ENGINEERING PROGRAM UPDATE Calculate changes to the program cost as a result of changes to the engine design and report cost reduction progress. Issuance of report.
5	VALUE ENGINEERING PROGRAM UPDATE Calculate changes to program cost as a result of changes to the engine design and report cost reduction progress. Issuance of report.
6	VALUE ENGINEERING PROGRAM UPDATE Calculate changes to program cost as a result of changes to the engine design and report cost reduction progress. Issuance of report.

2.05 Value Engineering



EVENT DICTIONARY


CONTINUE REPORTS
VALUE ENGINEERING PROGRAM UPDATE
7
C
12-69
VALUE ENGINEERING PROGRAM UPDATE
8
C
6-70
DATA FEEDBACK
DATA FEEDBACK
CONTINUE ESTIMATES
CONTINUE ESTIMATES
COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST
17
C
9-15-70
DATA FEEDBACK
DATA FEEDBACK
CONTINUE ANALYSIS
CONTINUE ANALYSIS

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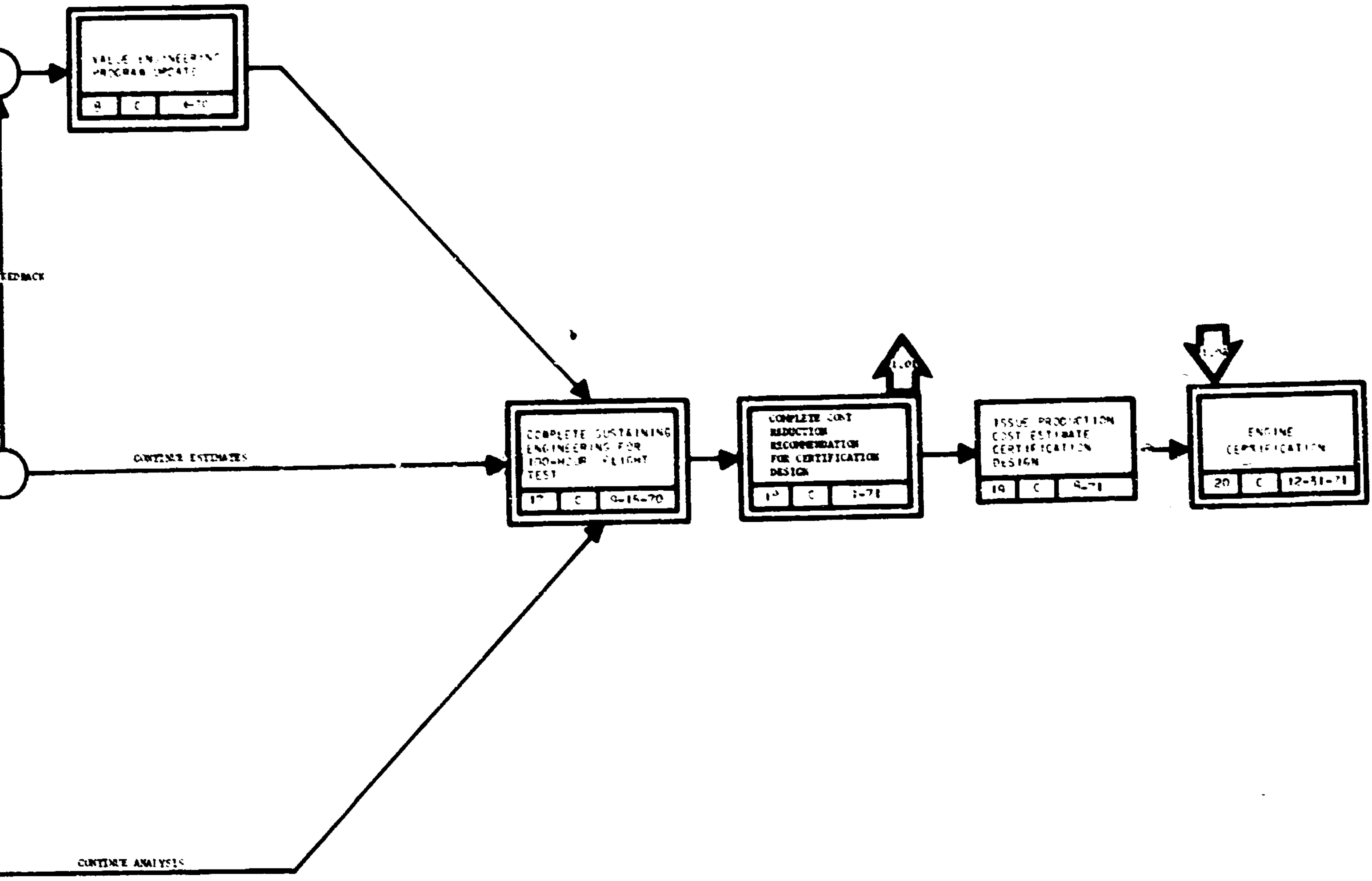

COMPLETE SUSTAINING ENGINEERING FOR
TEST
9-15-70
CONTINUE ESTIMATES
COMPLETE COST REDUCTION RECOMMENDATION FOR CERTIFICATION DESIGN
ISSUE PRODUCTION COST ESTIMATE CERTIFICATION DESIGN
19
ENGINE CERTIFICATION
20
12-31-71
CONTINUE ANALYSIS

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5

2.06 CONFIGURATION MANAGEMENT

Configuration Management is the system which controls the end-item configuration and provides engine and component part identification, engineering change control procedures and component and engine assembly accountability for the JTF17 and all Pratt & Whitney Aircraft commercial production engines. This system is described in detail in the Configuration Management Plan, Volume V, Report C.

The Engineering Change and change control procedure is the heart of this system. All changes to the engine model specification, engine and components assembly parts list, and assignment of part and serial numbers are implemented only by approved Engineering Changes. The system is applied throughout the program from the initial design layout, through detailed design, development, production, follow-on development, and service life of the engine.

To assure complete compatibility between the engine and the airframe manufacturer the close liaison developed in Phase II-C will be continued. This starts with the preparation of the engine model specification and engine definition and implementation of the established working procedures with the airframe manufacturer. The baseline control for this coordination will be the engine Model and Performance Specification, including the Installation Drawings. The instruments for providing this coordination are Field Survey layouts, correspondence and the Engineering Change control procedures. Engine mock-ups will be manufactured for engineering design and airframe manufacturer coordination requirements. The latter will also serve as a fixture to confirm final nacelle installation compatibility.

The major milestones, network chart and event dictionary for configuration management are shown in figures 9 and 10, respectively. Test planning and integration of configuration management is presented in Test, Volume IV, Report E.

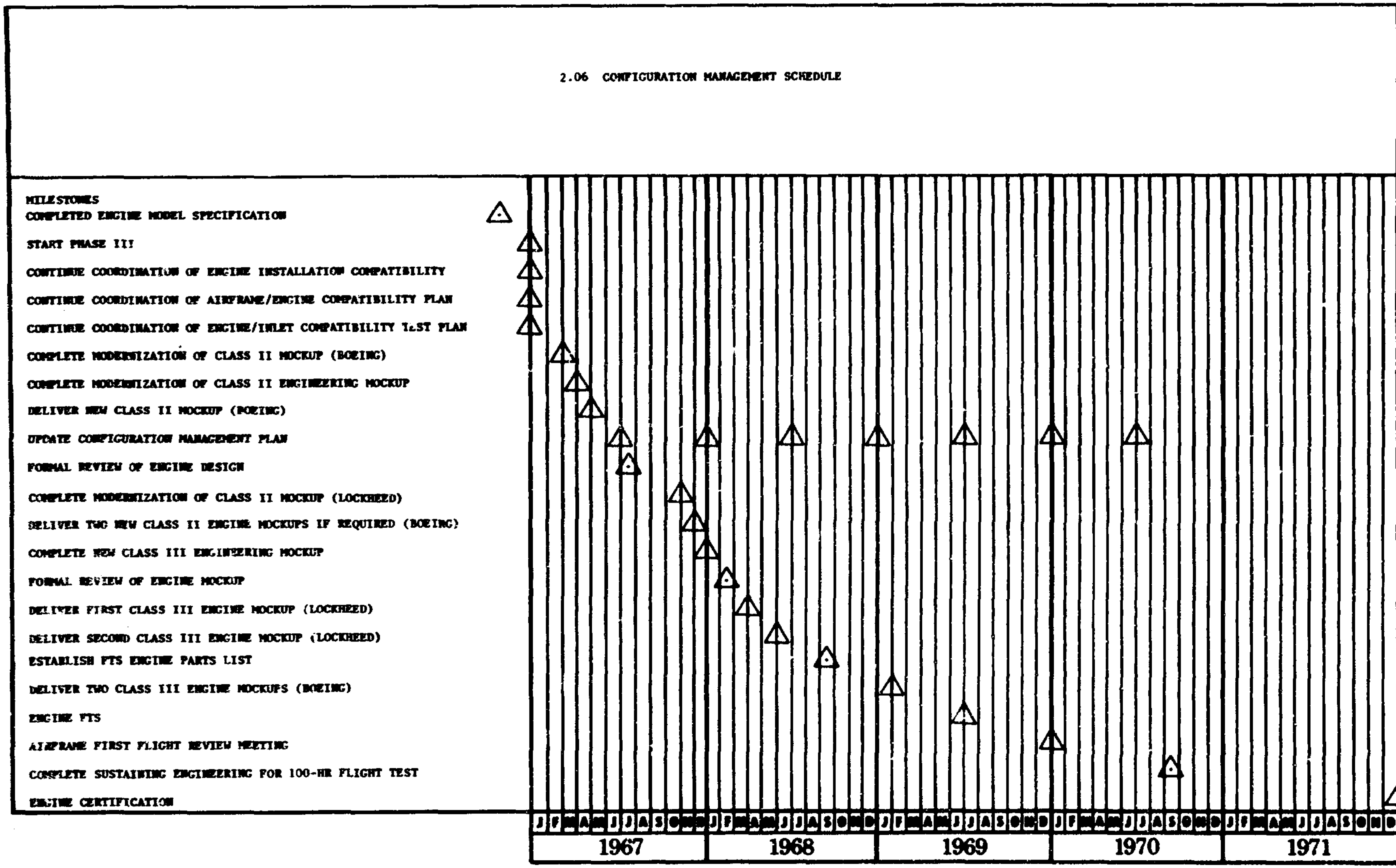

Figure 9. 2.06 Configuration Management

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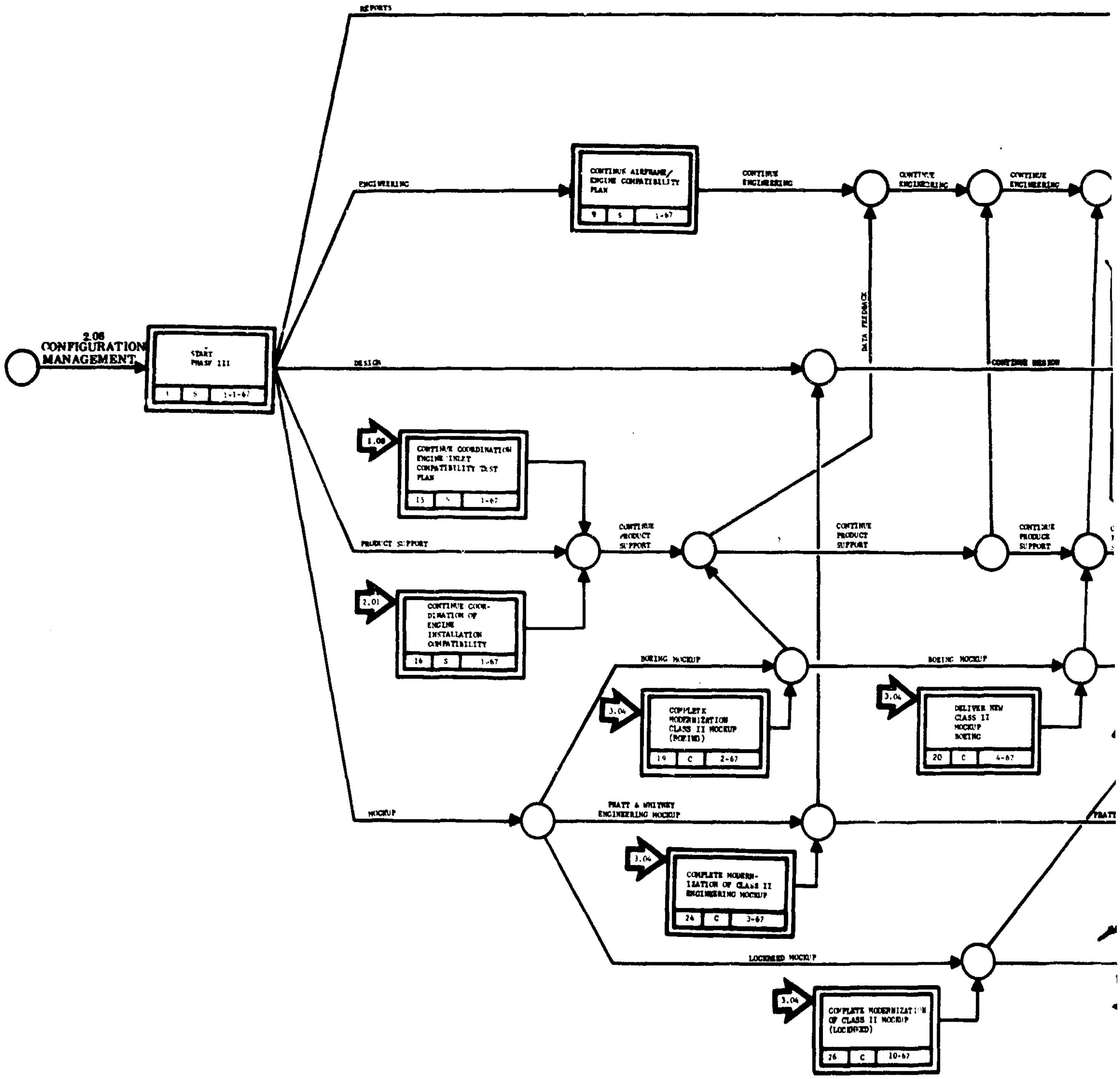
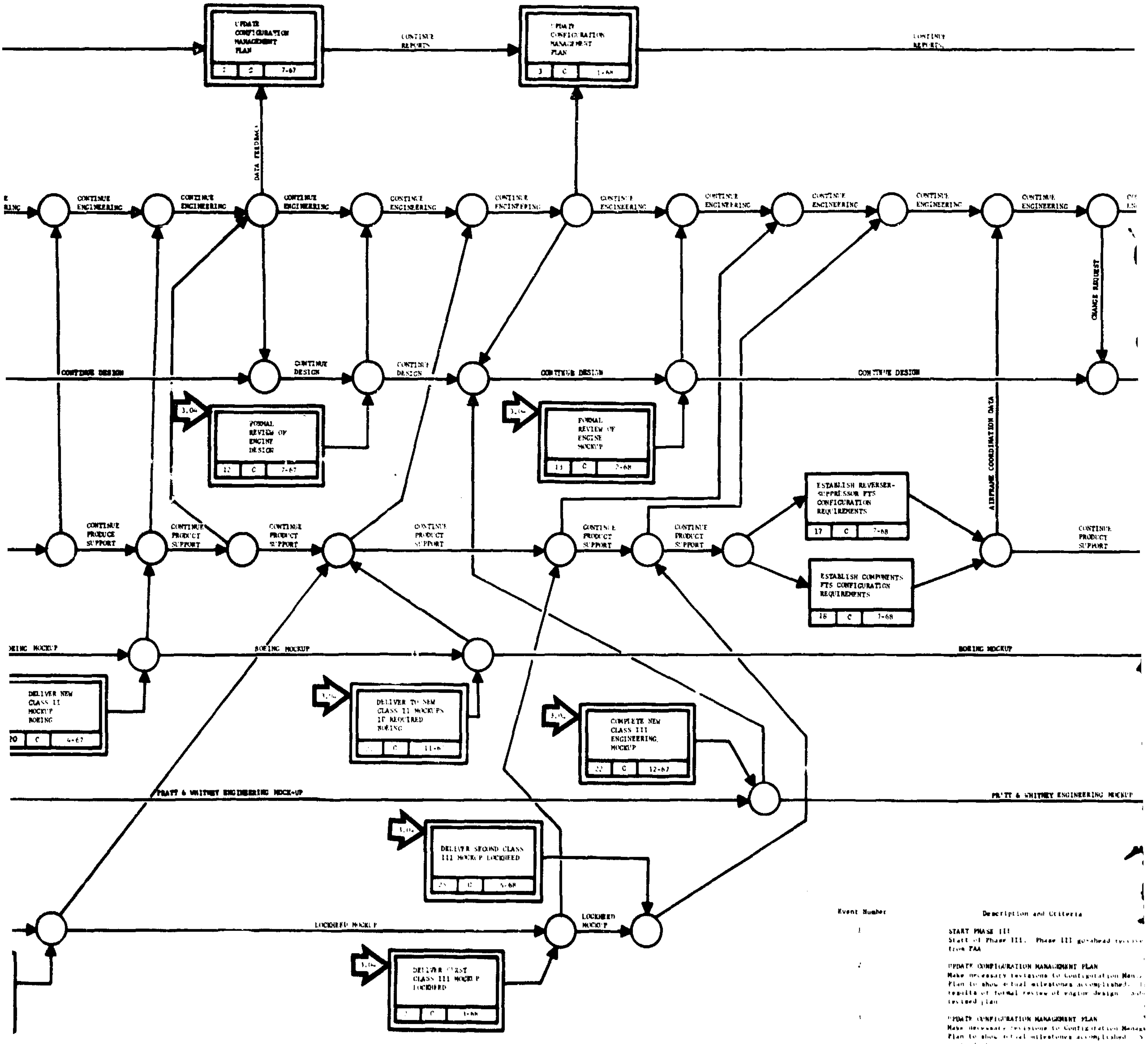


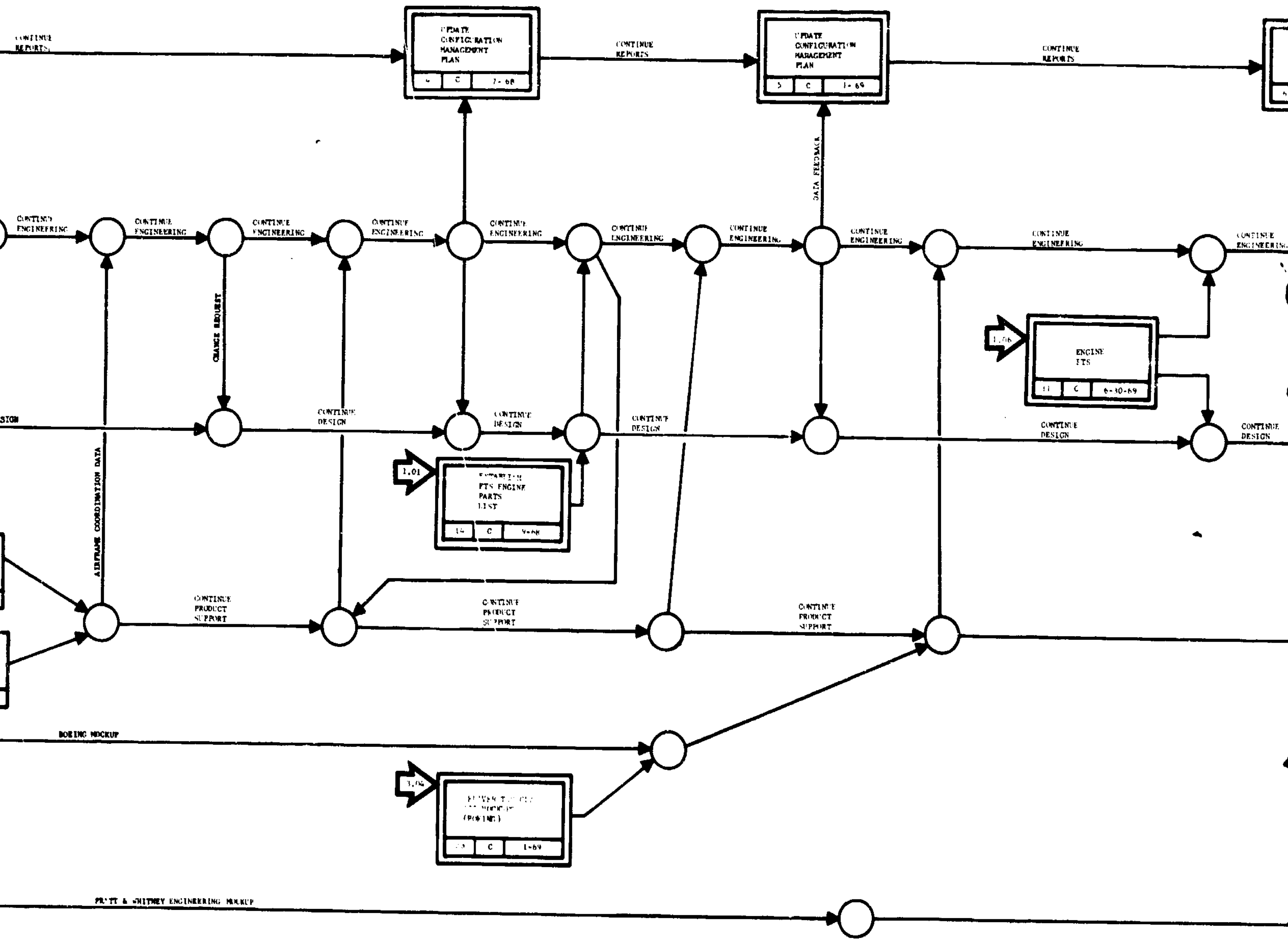
Figure 10. 2.06 Configuration Management



Event Number	Description and Criteria
1	START PHASE III Start of Phase III. Phase III go-ahead receive... from FAA
2	UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Man... Plan to show actual milestones accomplished. ... results of formal review of engine design. ... revised plan
3	UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Manag... Plan to show actual milestones accomplished. S... revised plan
4	UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Man... Plan to show actual milestones accomplished. ... revised plan
5	UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Manag... Plan to show actual milestones accomplished. S... revised plan

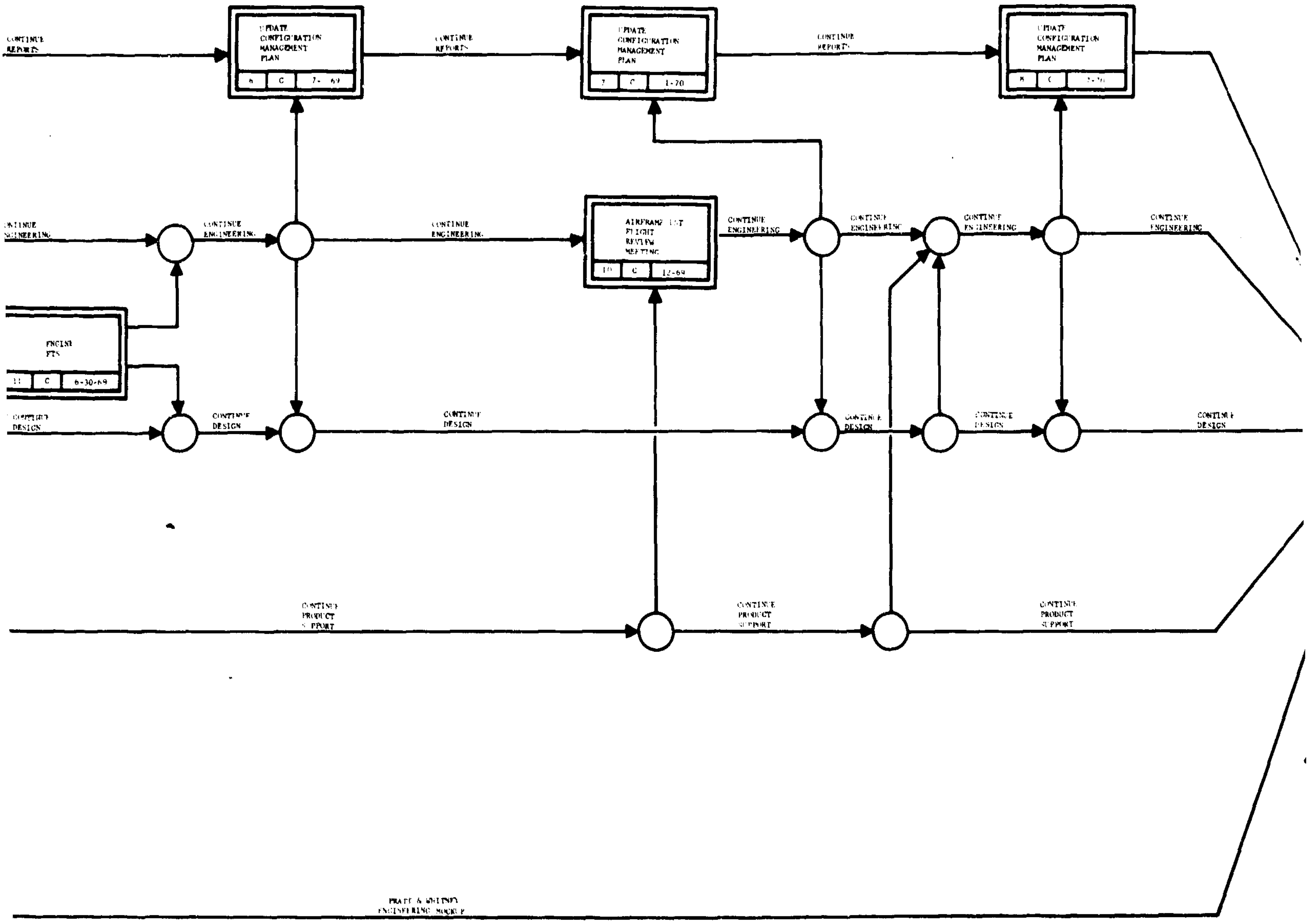
12

2.06 Configuration Management



EVENT DICTIONARY
2.06 CONFIGURATION MANAGEMENT

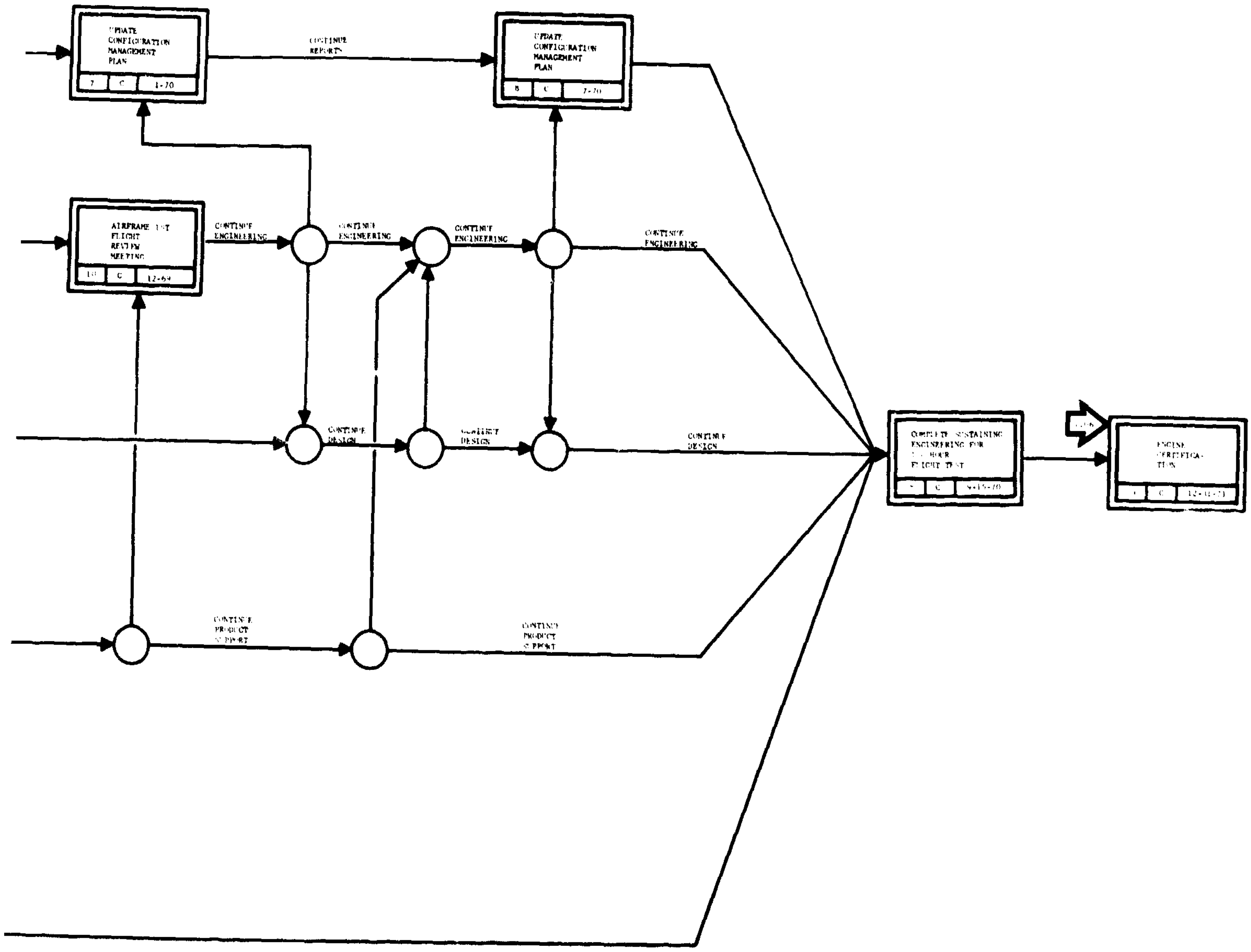
Description and Criteria	Event Number
START PHASE III Start of Phase III. Phase III go-ahead received from FAA	6
UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Management Plan to show actual milestones accomplished. Include results of formal review of engine design. Submit revised plan.	7
UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Management Plan to show actual milestones accomplished. Submit revised plan.	8
UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Management Plan to show actual milestones accomplished. Submit revised plan.	9
UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Management Plan to show actual milestones accomplished. Submit revised plan.	
UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Management Plan to show actual milestones accomplished. Submit revised plan.	10
UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Management Plan to show actual milestones accomplished. Submit revised plan.	11
UPDATE CONFIGURATION MANAGEMENT PLAN Make necessary revisions to Configuration Management Plan to show actual milestones accomplished. Submit revised plan.	12
CONTINUE AIRFRAME ENGINE COMPATIBILITY PLAN Monitor airframe engine compatibility by conducting regularly scheduled coordination meetings. Successful integration of engine with airframe	13
	14
AIRFRAME 1ST FLIGHT REVIEW MEETING Conduct flight review meeting with airframe Manufacturer. Complete flight review.	15
ENGINE FTS Reference engine network 1.06 for description and criteria.	
FORMAL REVIEW OF ENGINE DESIGN Conduct formal review of engine design with FAA airframe manufacturer and airlines. Complete formal review.	16
FORMAL REVIEW OF ENGINE MOCKUP Assemble Phase III mockup and conduct formal review. [illegible]	
ESTABLISH FTS ENGINE PARTS LIST Establish and release a Parts List for the FTS engine. [illegible] Release the Parts List.	
	18



EVENT DICTIONARY
CONFIGURATION MANAGEMENT

Event Number	Description and Criteria	Event Number	Description and Criteria	Event Number	Description and Criteria
[illegible]	**CONTINUE COORDINATION ENGINE INLET COMPATIBILITY TEST PLAN** [illegible]	19	**COMPLETE MODERNIZATION CLASS II MOCKUP (BOEING)** Assemble redesigned parts into Boeing mockup [illegible] assembly at Boeing	24	**COMPLETE MODERNIZATION OF CLASS II ENGINEERING MOCKUP** Assemble Class II Engineering mockup. Complete assembly
		20	**DELIVER NEW CLASS II MOCKUP (BOEING)** Complete assembly of first new Boeing Class II mockup. Deliver mockup to Boeing	25	**DELIVER SECOND CLASS III MOCKUP (LOCKHEED)** Assemble second Class III Lockheed mockup. [illegible] Class III mockup to Lockheed
[illegible]	**CONTINUE COORDINATION OF ENGINE INSTALLATION COMPATIBILITY** [illegible]	21	**DELIVER TWO NEW CLASS II MOCKUPS IF REQUIRED (BOEING)** Complete assembly of two new Boeing Class II mockups. Delivery of mockups to Boeing	26	**COMPLETE MODERNIZATION OF CLASS II MOCKUP (LOCKHEED)** Assemble [illegible] parts to convert Phase II [illegible] Class II mockup. Complete assembly Class II mockup
[illegible]	**ESTABLISH [illegible] FTS CONFIGURATION REQUIREMENTS** Establish design and compatibility prior to FTS [illegible] design to FTS engine	22	**COMPLETE NEW CLASS III ENGINEERING MOCKUP** Assemble Phase III Engineering mockup. Complete assembly of mockup	[illegible]	**DELIVER FIRST CLASS III MOCKUP (LOCKHEED)** [illegible] Class III mockup [illegible] Lockheed
[illegible]	**ESTABLISH COMPONENTS FOR FTS CONFIGURATION REQUIREMENTS** [illegible] component design compatibility for FTS configuration. Incorporate established component design into FTS configuration	23	**DELIVER TWO CLASS III MOCKUPS (BOEING)** Complete assembly of mockups. [illegible] Class III mockups to Boeing	[illegible]	**COMPLETE [illegible] TEST** [illegible] Phase III [illegible] testing
				[illegible]	**MOCKUP CERTIFICATION** Reference [illegible] for description and criteria

14



Event Number	Description and Criteria
[illegible]	[illegible]

Event Number	Description and Criteria
[illegible]	[illegible]
[illegible]	ENGINE CERTIFICATION [illegible]

5

2.07 SAFETY

The JTF17 engine Safety Plan presents Pratt & Whitney Aircraft's approach to assuring engine safety, and includes an Operational Safety Analysis of the engine installation. The safety plan establishes safety considerations during engine design and development in order to assure maximum safety during airframe/engine integration and operation of the Supersonic Transport. Details of this plan are described in Volume IV, Report C.

The primary objective of the Engine Safety Plan is the assurance of maximum safety consistent with other engineering parameters throughout the design, development, production, and service phases of the engine development program.

The philosophy used to ensure engine safety is to design safety into the engine so that operational hazards are at an absolute minimum. The safety program will require the preparation of Failure Mode and Effects Analyses (FMEA) which are an outgrowth of the Reliability Failure Mode and Effects Analyses, periodic design reviews for safety and trade-off studies against weight, performance, human engineering and reliability. This program also requires constant surveillance of the installed system to assure that safety aspects have been coordinated with the airframe manufacturer.

FAILURE MODE AND EFFECT ANALYSES

Hazardous failure modes and their effects will be identified, evaluated, and classified for all engine subassemblies. The design criteria will be reviewed and redesign will be accomplished to eliminate any failure mode classified as catastrophic. This effort will utilize data developed in conjunction with the Reliability Program.

All critical or catastrophic hazardous effects identified by this analysis will be corrected or reduced to a lower classification and reported in semi-annual reports.

DESIGN REVIEWS

The detailed subassembly and assembly design layouts will be reviewed from the overall engine safety point of view and reported. These design reviews will assure that the design criteria have been incorporated and that design weaknesses will be identified. Service information from current engines will be used to pinpoint the particular areas that have caused safety problems in the past. Particular attention will then be brought to bear on those areas to assure that design experience and improvements will be incorporated to reduce the probability of the occurrence of similar incidents. Any safety hazard uncovered by these reviews will immediately be brought to the attention of the Program Safety Engineer, the Project Engineers, the Chief Design Engineer, and the pertinent designers. Followup by the Program Safety Engineer will continue until the identified hazard is resolved.

Trade-off studies will be made throughout the program to determine the effect of safety considerations on reliability, weight perf..mance and maintainability. These trade-off studies will be documented, summarized and reports submitted during the program.

The major milestones, network chart and event dictionary for the safety program are shown in figures 11 and 12, respectively. Test planning and integration of safety is presented in Test, Volume IV, Report E.

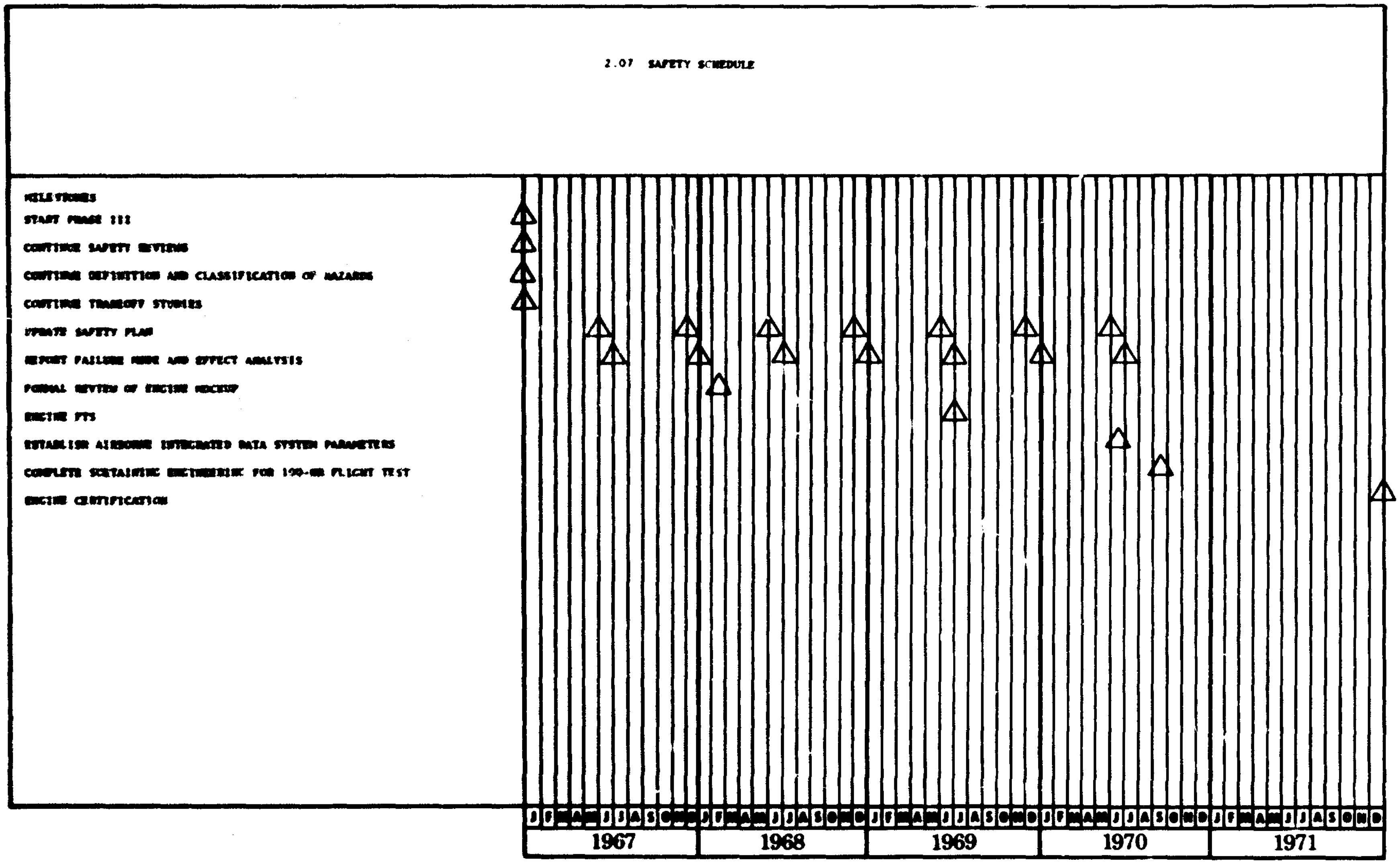


Figure 11. 2.07 Safety

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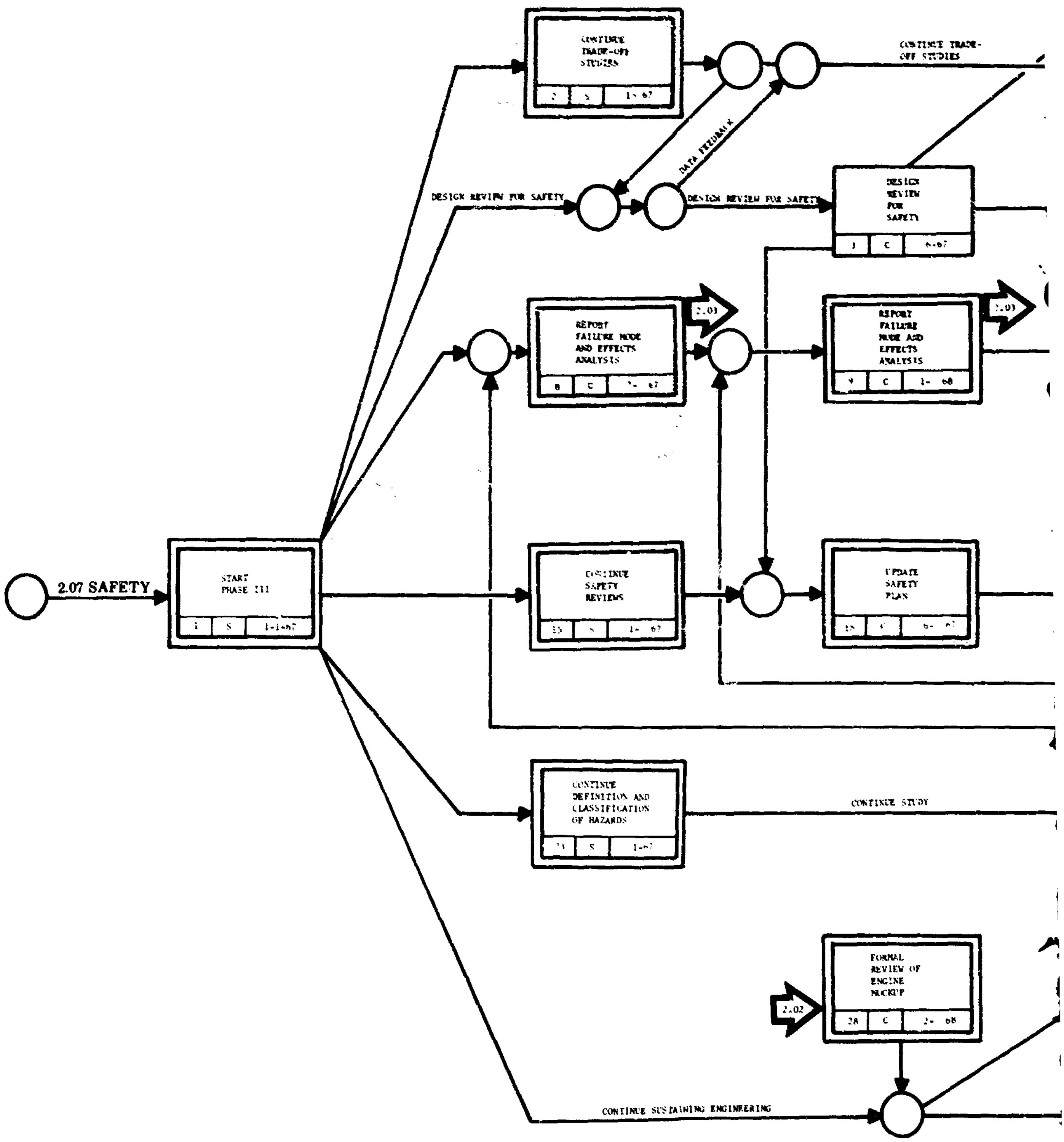

Event Number	Description and Criteria
1	**START PHASE III** Start of Phase III. Phase III go-ahead received from FAA.
2	**CONTINUE TRADE-OFF STUDIES** Continue design studies of factors affecting safety and the trade-off effects on other engine parameters.
3	**DESIGN REVIEW FOR SAFETY** Review of all layouts for safety. Approval and issuance of layout.
4	**COORDINATION OF AIRFRAME/ENGINE INTERFACE SAFETY** Ensure that safety considerations have been satisfied by means of Field Survey layouts. Approval and release of layouts.
5	**COORDINATION OF AIRFRAME ENGINE INTERFACE SAFETY** Ensure that safety considerations have been satisfied by ways of Field Survey layouts. Approval and release of layouts.

Event Number	Description and Criteria
6	**DESIGN REVIEW FOR SAFETY** Review of all layouts for safety. Approval and issuance of layout.
7	**DESIGN REVIEW FOR SAFETY** Review of all layouts for safety. Approval and issuance of layout.
8	**FAILURE MODE AND EFFECTS ANALYSIS** Include safety definition and classifications in FMEA. Include design philosophy to resolve hazards. Issuance of FMEA report.
9	**FAILURE MODE AND EFFECTS ANALYSIS** Include safety definition and classifications in FMEA. Include design philosophy to resolve hazards. Issuance of FMEA report.
10	**FAILURE MODE AND EFFECTS ANALYSIS** Include safety definition and classifications in FMEA. Include design philosophy to resolve hazards. Issuance of FMEA report.

Event Number
11
12
13
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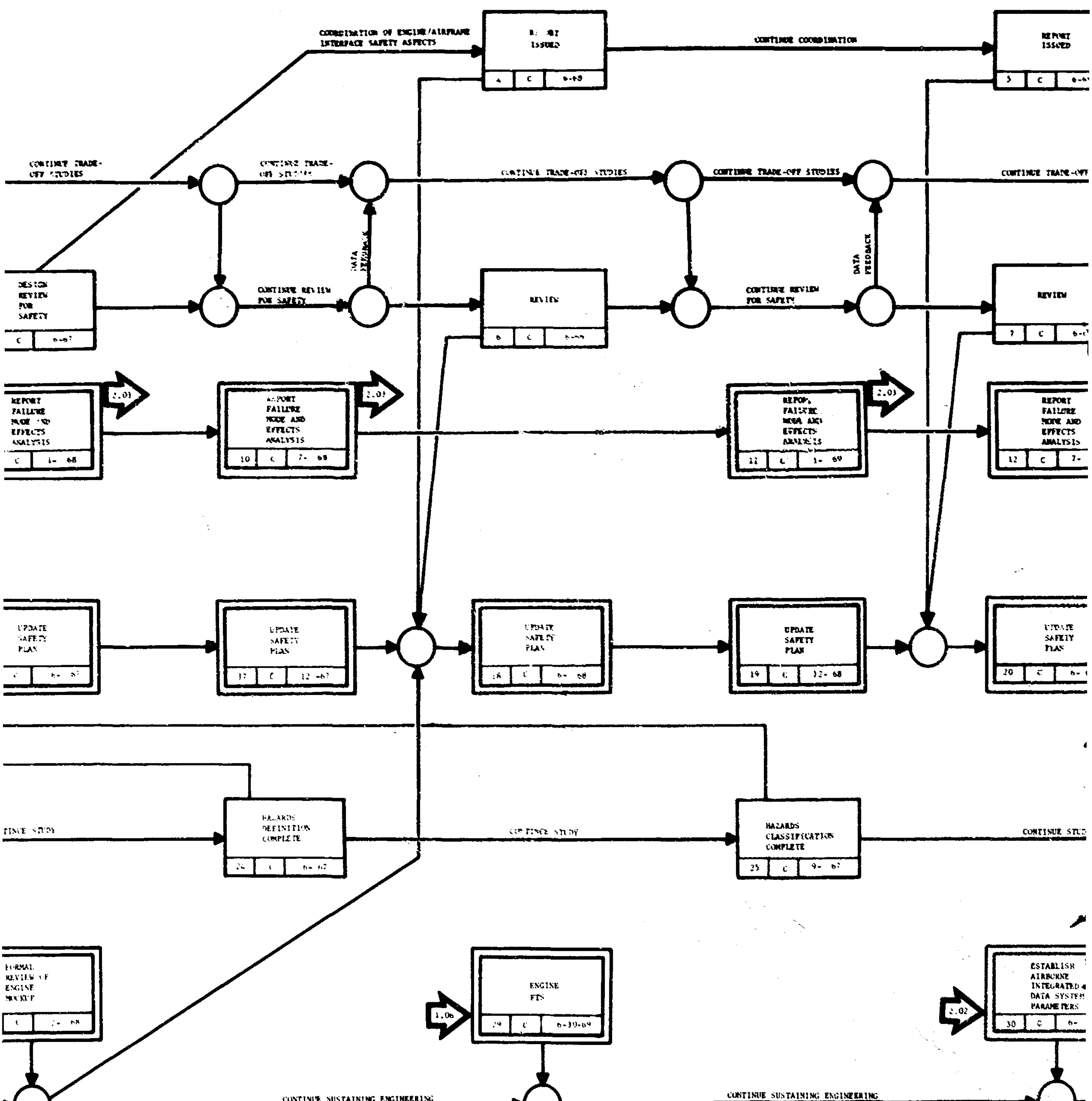
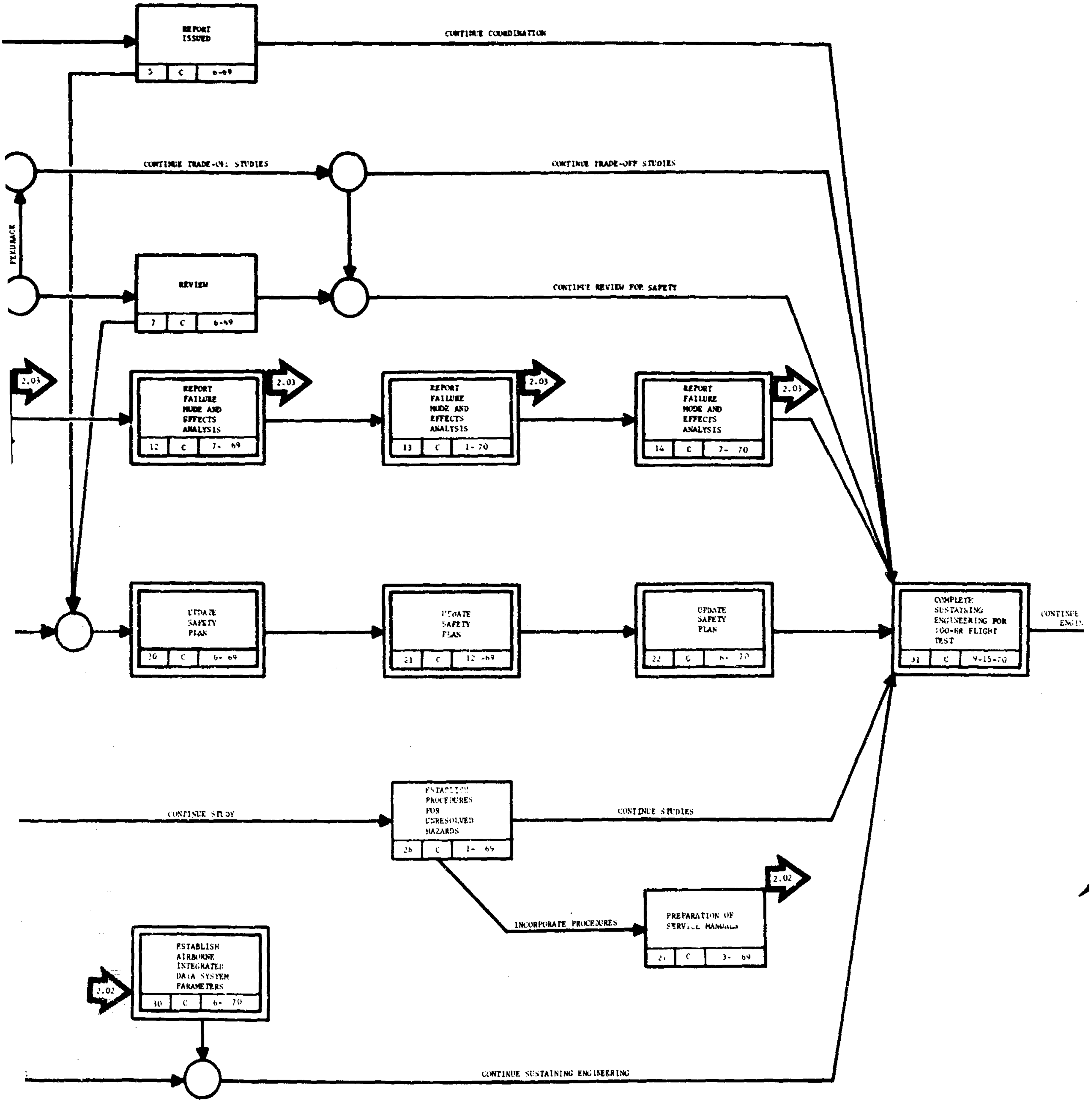
Figure 12. 2.07 Safety

2.07 Safety



EVENT DICTIONARY
2.07 SAFETY

Event Number	Description and Criteria	Event Number	Description and Criteria	Event Number	
11	FAILURE MODE AND EFFECTS ANALYSIS Include safety definition and classifications in FMEA. Include design philosophy to resolve hazards. Issuance of FMEA report.	15	CONTINUE SAFETY REVIEWS Continue review of safety for documentation. Phase III go-ahead.	20	ENGINE SAF Update eng taken to r from desig Safety Pla
12	FAILURE MODE AND EFFECTS ANALYSIS Include safety definition and classifications in FMEA. Include design philosophy to resolve hazards. Issuance of FMEA report.	16	ENGINE SAFETY PLAN Update engine safety plan to reflect action taken to resolve hazards. Include results of design reviews. Issuance of updated Safety Plan.	21	ENGINE SAF Update eng taken to r design rev
13	FAILURE MODE AND EFFECTS ANALYSIS Include safety definition and classifications in FMEA. Include design philosophy to resolve hazards. Issuance of FMEA report.	17	ENGINE SAFETY PLAN Update engine safety plan to reflect action taken to resolve hazards during development testing. Issuance of updated Safety Plan.	22	ENGINE SAF Update eng taken to r engineerin design rev Plan.
[illegible]	FAILURE MODE AND EFFECTS ANALYSIS Include safety definition and classifications in FMEA. Include design philosophy to resolve hazards. Issuance of FMEA report.	18	ENGINE SAFETY PLAN Update engine safety plan to reflect action taken to resolve hazards. Include results of design reviews. Issuance of updated Safety Plan.	23	[illegible]
		19	ENGINE SAFETY PLAN Update engine safety plan to reflect action taken to resolve hazards. Include results from design reviews. Issuance of updated Safety Plan.		

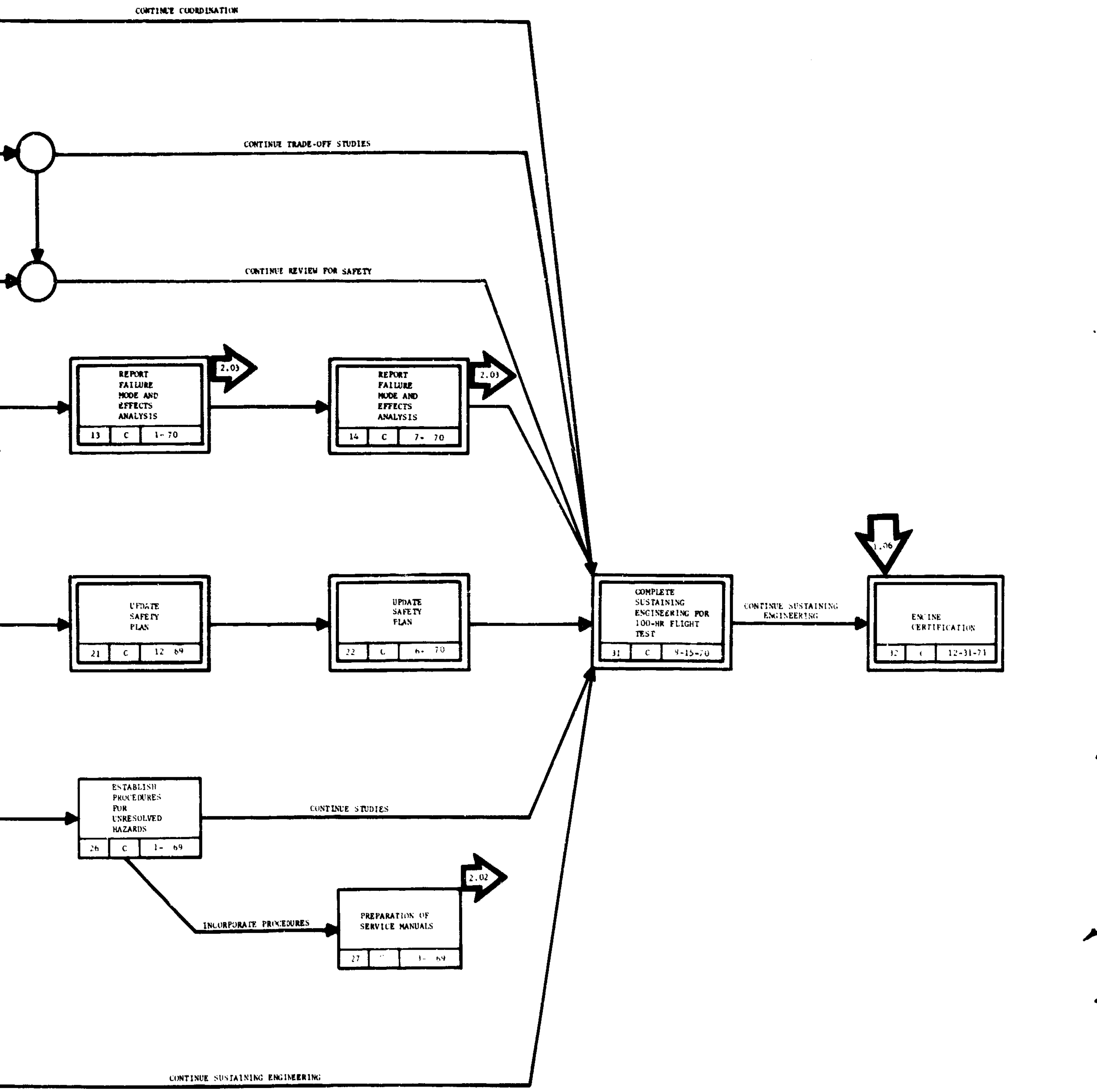


Event Number	Description and Criteria
20	**ENGINE SAFETY PLAN** Update engine safety plan to reflect action taken to resolve hazards. Include results from design reviews. Issuance of updated Safety Plan.
21	**ENGINE SAFETY PLAN** Update engine safety plan to reflect action taken to resolve hazards. Include results of design reviews. Issuance of updated Safety Plan.
22	**ENGINE SAFETY PLAN** Update engine safety plan to reflect action taken to resolve hazards and approve human engineering features. Include results of design reviews. Issuance of updated Safety Plan.
23	**CONTINUE DEFINITION AND CLASSIFICATION OF HAZARDS** Continue to compile the hazard definition list. Continue to classify all hazards added to the definition list according to critical portions of flight.

Event Number	Description and Criteria
24	**COMPLETE HAZARD DEFINITION** Compile hazard definition list. Incorporate results in FMEA.
25	**CLASSIFICATION OF HAZARDS** Classify all hazards according to critical portions of flight. Compile list of action taken to resolve hazards and include in FMEA.
26	**PROCEDURE FOR UNRESOLVED HAZARDS** Establish procedures to provide safe operation for unresolved hazards. Compile list of procedures for unresolved hazards for incorporation in manuals.
27	**PREPARATION OF SERVICE MANUALS** Incorporate procedures for unresolved hazards in Service Manuals and Operating Instructions. Issuance of revisions to Service Manuals.
28	**FORMAL REVIEW OF ENGINE MOCKUP** Conduct formal review of Engineering Mockup. Inclusion of review results in Engine Safety Plan.

Event Number	Descr
29	**ENGINE FTS** Reference engine and criteria.
30	**AIRBORNE INTEGRA** Review and [illegible] safety considerat to airframe manuf
31	**COMPLETE SUSTAINI** **FLIGHT TEST** End Phase III. [illegible] flight to time.
32	**ENGINE CERTIFICAT** Reference engine and criteria.

3



riteria

reflect action
nclude results
of updated

reflect action
nclude results of
updated Safety Plan.

reflect action
improve human
results of
updated Safety

FICATION OF HAZARDS
rd definition list.
ards added to the
critical portions

Event Number	Description and Criteria
24	COMPLETE HAZARD DEFINITION Compile hazard definition list. Incorporate results in FMEA.
25	CLASSIFICATION OF HAZARDS Classify all hazards according to critical portions of flight. Compile list of action taken to resolve hazards and include in FMEA.
26	PROCEDURE FOR UNRESOLVED HAZARDS Establish procedures to provide safe operation for unresolved hazards. Compile list of procedures for unresolved hazards for incorporation in manuals.
27	PREPARATION OF SERVICE MANUALS Incorporate procedures for unresolved hazards in Service Manuals and Operating Instructions. Issuance of revisions to Service Manuals.
28	FORMAL REVIEW OF ENGINE MOCKUP Conduct formal review of Engineering Mockup. Inclusion of review results in Engine Safety Plan.

Event Number	Description and Criteria
29	ENGINE FIS Reference engine network 1.06 for description and criteria.
30	AIRBORNE INTEGRATED DATA SYSTEM Review and establish aids parameters to ensure safety considerations. Submit aids parameters to airframe manufacturer.
31	COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST End Phase III. Completion of 100 hours of flight testing.
32	ENGINE CERTIFICATION Reference engine network 1.06 for description and criteria.

4

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2.08 TEST PLANNING AND INTEGRATION

Careful integration of the engine and component test programs is provided to assure that the JTF17 engine development program will proceed in the most expeditious manner to achieve the required engine performance and maturity.

The Project Group directs the test integration program. Experimental engineers from this group define each test to be conducted, determine the instrumentation required and its accuracy, and personally direct each test. Integration of test results is a continuous process through the interrelation of Assistant Project Engineers and Project Engineers within the Project Group, each upward level of technical direction having a wider sphere of responsibility over the detail parts, components, subassemblies, and assemblies which in total make up the engine.

The test integration process begins with the release of an initial design to Manufacturing by means of an Experimental Release from Design by Project Engineering. Following the completion of manufacturing, the parts are delivered to Assembly by means of parts requisitions, and the assembly instructions are provided by experimental engineer's memoranda. The assembled engine or components are delivered to test together with instructions for installation on the test stand, including instrumentation requirements. Specific test instructions and test programs are provided by experimental engineer's memoranda.

All engine and component testing requires data recording with most engine and major component tests utilizing automatic data acquisition. Automatic data printout sheets and test stand log sheets are transmitted to the Performance Group for performance analysis. The results of the performance analysis are presented to Project Engineering for use in continued program planning. Minor component test data may bypass this portion of the flowpath with the test data transmitted directly to Project Engineering. These data are analyzed by the Project Group to determine if performance or mechanical deficiencies exist. If a deficiency exists, a comprehensive failure analysis is conducted to determine corrective action. This analysis is conducted by members of the Project Group, Performance, Reliability and Safety, Design, and Materials Laboratory. Corrective action for the deficiency is then coordinated by Project Engineering with Design, and design changes are requested by memoranda. When completed, these changes are approved by Project Engineering prior to release for experimental parts manufacture.

Statistical methods will be applied during the pretest planning to assist in the test integration. Component and engine test programs are devised to obtain the maximum relevant information from each test by (1) proper design of experiments, (2) analysis of instrumentation precision and accuracy, (3) statistical data analysis, and (4) the measurement of the uncertainty associated with the estimates and conclusions based on experimental data. Statistical methods will also be used in optimizing computer data reduction programs, determining instrumentation requirements and calibration methods, and in the analysis of reliability data.

The major milestones and test integration chart for the test planning and integration program are shown in figure 13 and figure 3 of Volume IV, Report E.

A detailed description of test planning and integration is presented in Test, Volume IV, Report E.

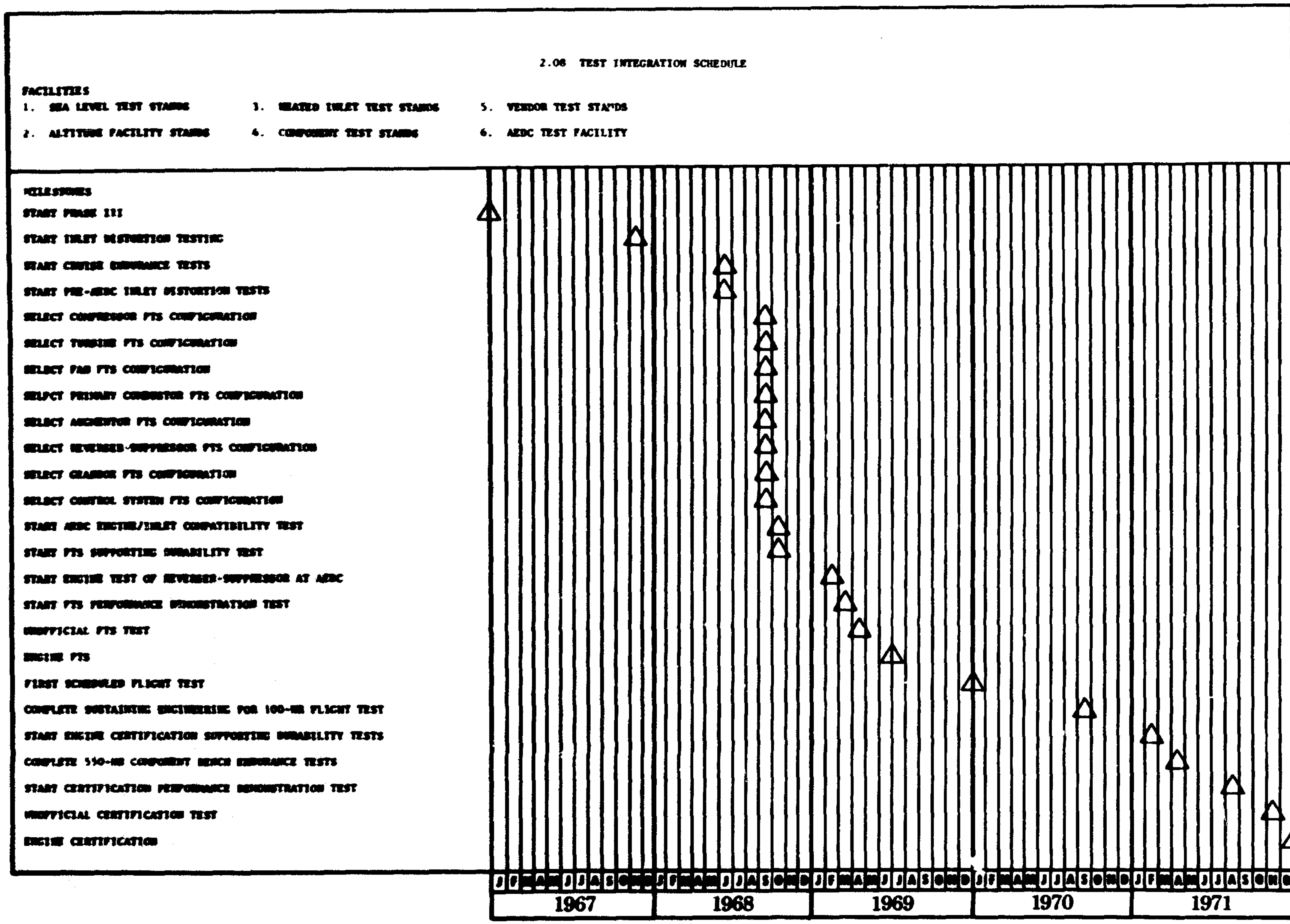

Figure 13. 2.08 Test Planning and Integration

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2.09 DATA MANAGEMENT

The Data Management Plan describes the program which Pratt & Whitney Aircraft will implement to generate, collect, store, and distribute significant technical, financial, and managerial data. These data will be used to facilitate program monitoring and decision making, promote economy, expedite coordination, and inform the FAA, airframe contractor, and the airlines.

Included in the Data Management Plan, Volume V, Report D, are the data management group organization and functional responsibilities, and the Data Requirement Document, which describes the data that will be generated in the development program. Table 1 presents a Data List and submission schedule.

Table 1. Data List

Item	Title	Submittal Date	Frequency
1	Progress Report	March 1967	2 Months
2	Data Management Plan Update	May 1967	6 Months
3	Data Accession List	March 1967	2 Months
4	Data Requirements Document Update	May 1967	6 Months
5	Configuration Management Plan Update	July 1967	6 Months
6	Model and Performance Specifications		
	Preliminary	July 1967	6 Months
	Firm	Prior to Phase III Completion	
7	Engineering Change Proposal	As required	
8	Configuration Inspection and Review Plan	July 1967	6 Months
9	Cost Status Report	February 1967	Monthly
10	Schedule Status Report	February 1967	Monthly
11	Detail Work Plan Update	February 1967	Update as required
12	Cost Baseline Report	September 1967	Annual
13	Cost Control System Update	February 1967	Update as required
14	Schedule Control System Update	February 1967	Update as required
15	Control Room Data	As required	
16	Subcontract Plan Update	April 1967	Update as required
17	Value Engineering Program Update	June 1967	6 Months
18	Annual Report	January 1968	Annual
19	Final Report	Phase III Conclusion	
20	Data Central File	March 1967	2 Months
21	Maintainability Program Update	August 1967	6 Months
22	Airline Maintenance Plan	December 1969	
23	Systems Safety Plan Update	June 1967	6 Months
24	Product Support Program Including Training and Training Equipment Program Update	July 1967	6 Months
25	Reliability Program Update	July 1967	6 Months
26	Quality Assurance Program Update	August 1967	6 Months

Table 1. Data List (Continued)

Item	Title	Submittal Date	Frequency
27	Integrated Test Program Update	August 1967	Monthly
28	Facilities Plan Update	July 1967	As required
29	Master Program Plan Update	June 1967	6 Months
30	High Risk Area Report	February 1967	2 Months
31	Human Engineering Program Update	June 1967	6 Months
32	Follow-on Proposal	Prior to Phase III Completion	
33	Flash Failure Report	As generated	
34	Subcontractor Acceptance/Qualification Test Report	As generated	
35	Engine FTS Test Plan	6 months prior to start of test	
36	Final FTS Test Report	30 days after completion	
37	Final Report of Inlet/Engine Compatibility Testing	90 days after completion	
38	Final Report of Government Facility Testing	30 days after receipt of data from Government Facility	
39	Final Report of 100-Hour Flight Test	30 days after completion	
40	Phases III and IV Detailed Test Plans	July 1967	6 Months
41	Engine Status and Usage Records	February 1967	Monthly
42	Failure and Analysis Report	As generated	
43	Engine Installation Manual	July 1967	6 Months
44	Engine Flight Test Report	As generated	
45	Manufacturing Program Update	July 1967	6 Months

2.10 PROGRAM MANAGEMENT AND CONTROLS

Pratt & Whitney Aircraft will prepare and maintain key plans to implement the management and controls required to ensure successful and timely completion of the JTF17 engine development and flight test programs. The following plans are included in the total management effort and will be used to promote economy, facilitate decisions and program monitoring, expedite coordination and provide information to the FAA, airframe contractor and the airlines:

Plan	Proposal Location
Cost and Schedule Control Plan	Volume V, Report F
Subcontract Plan	Volume V, Report E
Master Program Plan	Volume V, Report A
Program Review Plan	Volume V, Report A
Detail Work Plan	Volume V, Report H

2.11 FACILITIES PLAN

For the performance of the Supersonic Transport Engine Development Program through Phase III, Pratt & Whitney Aircraft will make available, if required, the existing supersonic engine development facilities at the Florida Research and Development Center, and at the main plant in Connecticut. Additional capital facilities required for the performance of Phase III of the engine development program will also be furnished together with the additional capital facilities required for the manufacture of ground and flight test engines. The use of Government facilities will be required during the development program for engine-inlet system compatibility testing and engine reverser-suppressor performance testing described in Volume III, Report D, Section II, and Volume III, Report E, Section III, respectively.

The following modifications or additions are planned for the JTF17 engine sea level and altitude test stands, component test stands, and manufacturing equipment and space:

SEA LEVEL TEST STANDS

1. Modify test stand A-5 to accommodate the JTF17 engine
2. Build a new reverser test stand, A-9
3. Modify two sea level engine stands, A-6 and A-7, for prototype and overhaul engine test
4. Install additional fuel supply tanks and fuel distribution system, extend the data acquisition system, and add a starter air supply system to the sea level test area.

ALTITUDE TEST STANDS

1. Modify high Mach number test stand C-4 to add full Mach number range and airflow capability
2. Build an additional test stand C-6 with full Mach number range and airflow capability
3. Build a new test stand C-7 with the capability of testing engine full-scale fan and high compressors using heated inlet air
4. Provide increased airflow capacity in the high Mach laboratories by installing additional compressors, exhausters, heaters, air scrubbers and the related drives, ducting and valves
5. Modify test stand X-210 (Willgoos Laboratory) to provide refrigeration capabilities for low temperature operating conditions.

HEATED INLET TEST STANDS

1. Build a new test stand, C-8, to provide rammed heated inlet and altitude exhaust capability
2. Build a new test stand, C-9, to provide rammed heated inlet and altitude exhaust capability
3. Build a new test stand, C-10, to provide rammed heated inlet and altitude exhaust capability.

COMPONENT TEST STANDS

1. Modify test bench D-7 to provide increased air supply, air heater, revised drive and mounts
2. Modify test bench D-10 to provide increased air supply
3. Modify test bench D-11 to provide increased air, fuel and electrical systems
4. Modify test bench D-12 to provide increased air, fuel and electrical systems
5. Modify test bench D-16 to provide increased fuel system
6. Modify test bench D-18 to provide increased air, fuel, drive and electrical systems
7. Modify test bench D-24 to provide increased air and drive capabilities
8. Modify test benches for ignition systems to provide increased electrical and temperature capabilities
9. Build two new electronic fuel control test benches
10. Build new fuel control, hydraulic pump and fuel nozzle flow benches for prototype and overhaul program.

MANUFACTURING

1. The necessary manufacturing and inspection tools and equipment will be provided
2. An additional 96,000 square feet of floor space will be constructed.

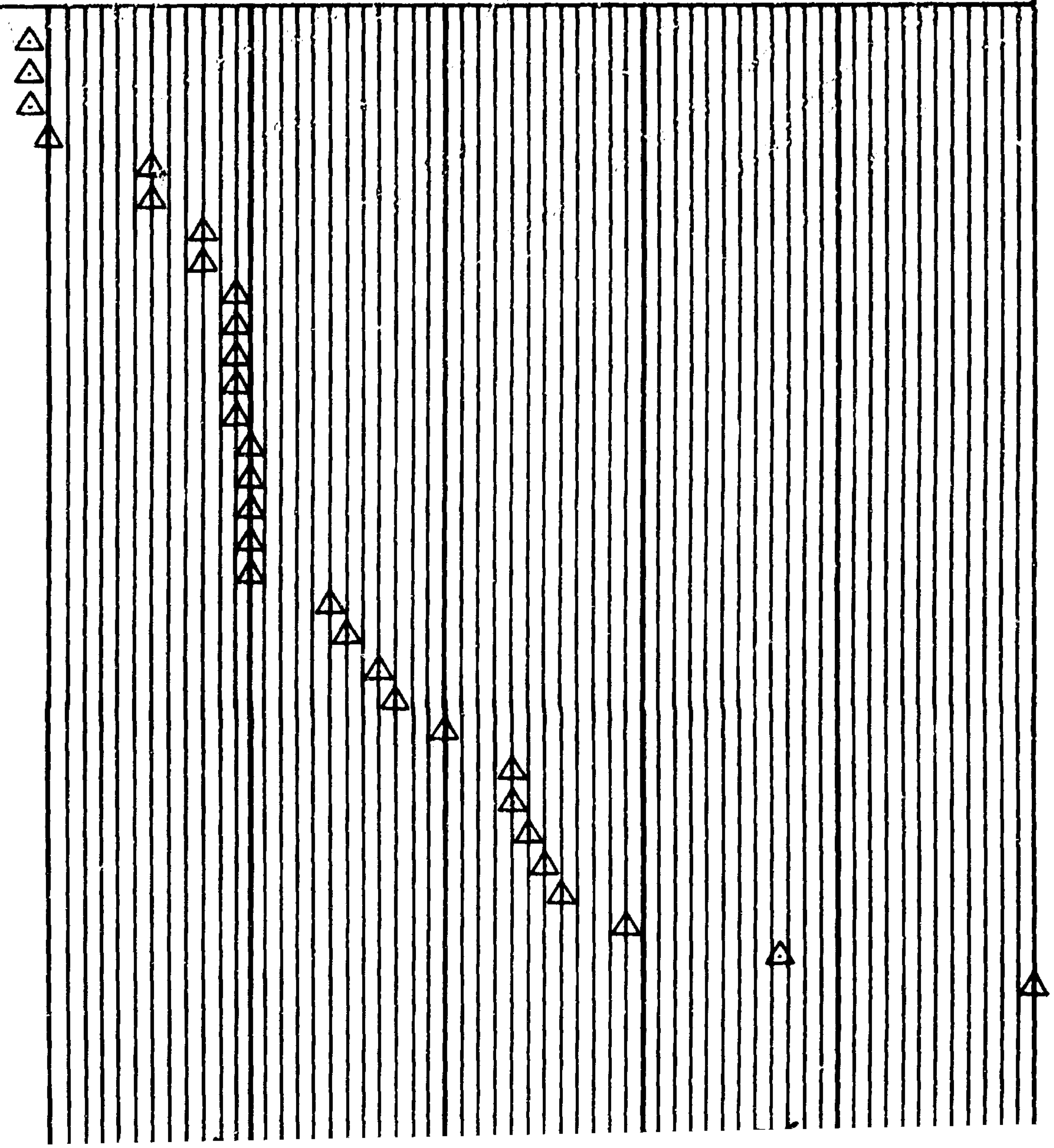
The major milestones, network charts and event dictionaries for the facilities are shown in figures 14 and 15, respectively.

A complete and detailed Facilities Plan is presented in Volume V, Report B. Test planning and integration of facilities is presented in Test, Volume IV, Report E.

2.11 FACILITIES SCHEDULE

FACILITIES
1. MANUFACTURING FACILITIES
2. VENDOR FACILITIES

MILESTONES
- COMPLETED SEA LEVEL TEST STAND A-3
- COMPLETED SEA LEVEL TEST STAND A-4
- COMPLETED ALTITUDE FACILITY STAND C-4
- START PHASE III
- COMPLETE SEA LEVEL REVERSER STAND A-9
- COMPLETE IGNITION SYSTEM ALTITUDE TEST BENCH
- COMPLETE IGNITION SYSTEM ENVIRONMENTAL TEST BENCH
- COMPLETE SEA LEVEL TEST STAND A-5
- COMPLETE HIGH TEMPERATURE FUEL CONTROL SYSTEM TEST BENCH D-7
- COMPLETE FUEL PUMP TEST BENCH D-10
- COMPLETE FUEL CONTROL TEST BENCH D-12
- COMPLETE HYDRAULIC PUMP TEST BENCH D-16
- COMPLETE ELECTRONIC CONTROL TEST BENCHES
- COMPLETE ADDITIONAL MANUFACTURING EQUIPMENT AND FLOOR SPACE
- COMPLETE ALTITUDE FACILITY STAND C-7
- COMPLETE FUEL CONTROL TEST BENCH D-11
- COMPLETE FUEL CONTROL TEST BENCH D-18
- COMPLETE COMPONENT TEST STAND D-24
- COMPLETE HEATED INLET TEST STAND C-8
- COMPLETE WILLGOOS LABORATORY TEST STAND X-210
- COMPLETE HEATED INLET TEST STAND C-9
- COMPLETE ALTITUDE FACILITY STAND C-6
- COMPLETE HEATED INLET TEST STAND C-10
- COMPLETE PROTOTYPE SHOP AND INSPECTION EQUIPMENT
- COMPLETE PROTOTYPE COMPONENT TEST BENCHES
- COMPLETE PROTOTYPE SEA LEVEL TEST STAND A-6
- ENGINE PTS
- COMPLETE PROTOTYPE SEA LEVEL TEST STAND A-7
- COMPLETE REMODIFICATION OF ALTITUDE FACILITY STAND C-4
- COMPLETE SUSTAINING ENGINEERING FOR 100-HR FLIGHT TEST
- ENGINE CERTIFICATION



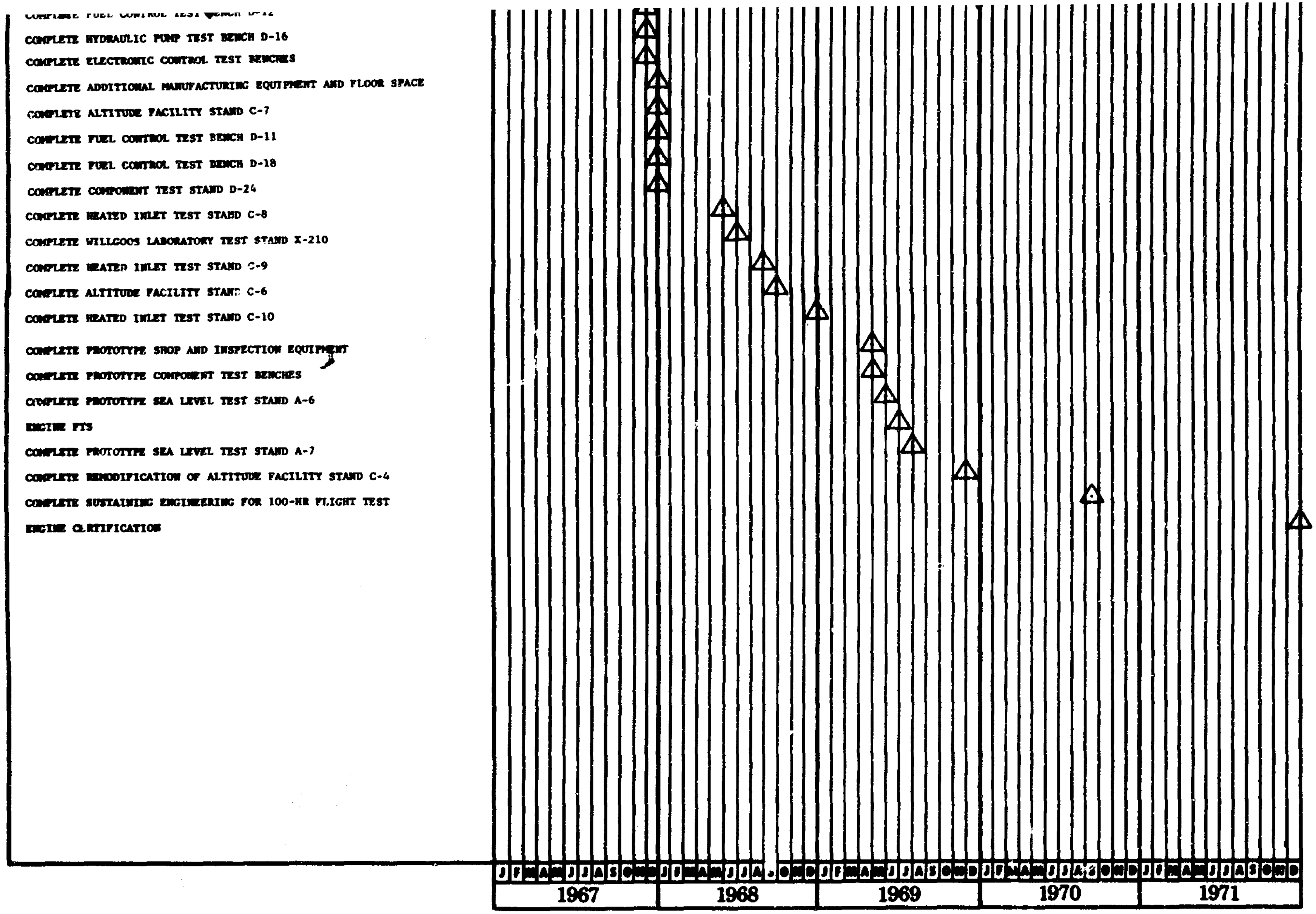


Figure 14. 2.11 Facilities Plan

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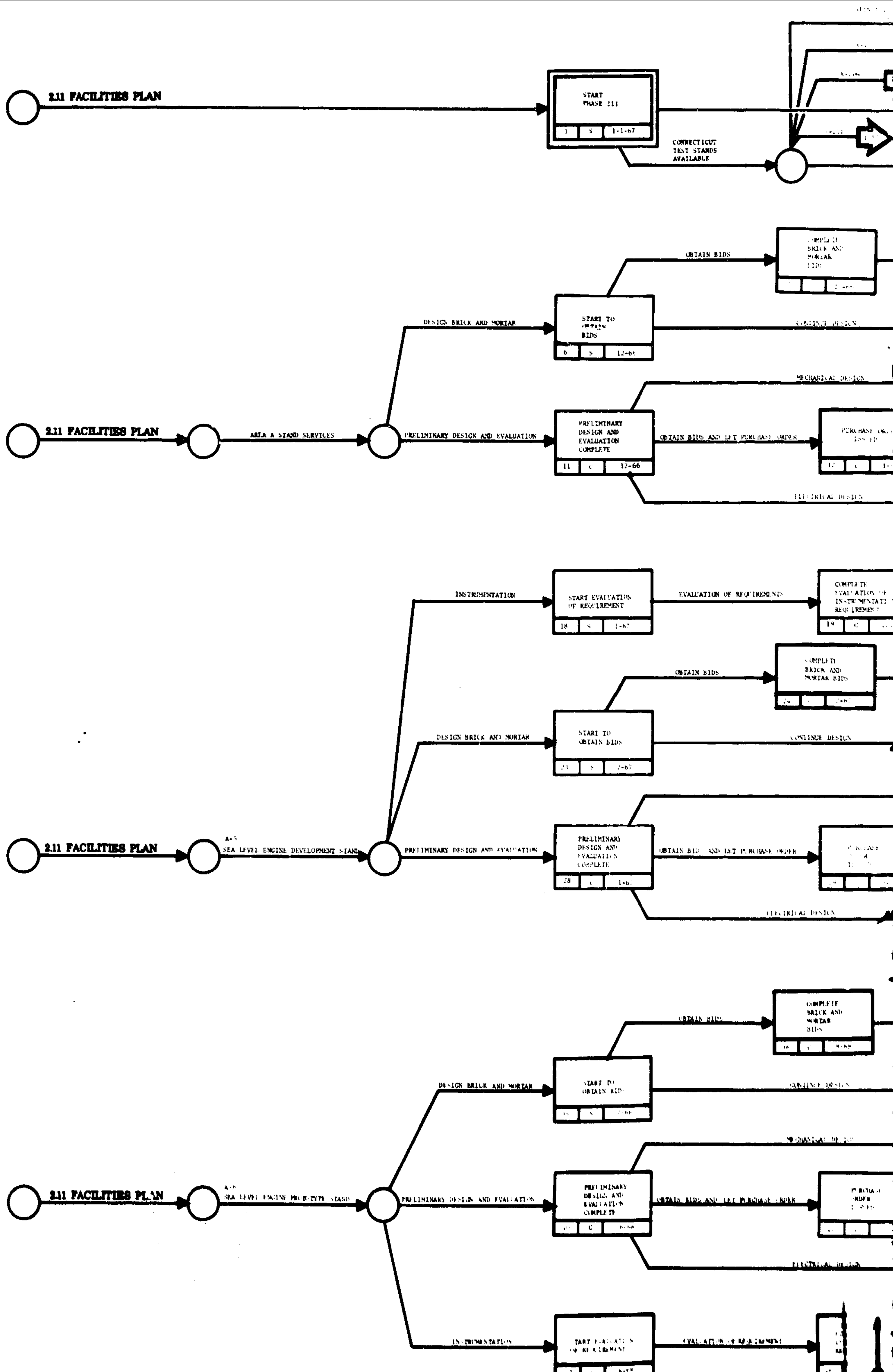
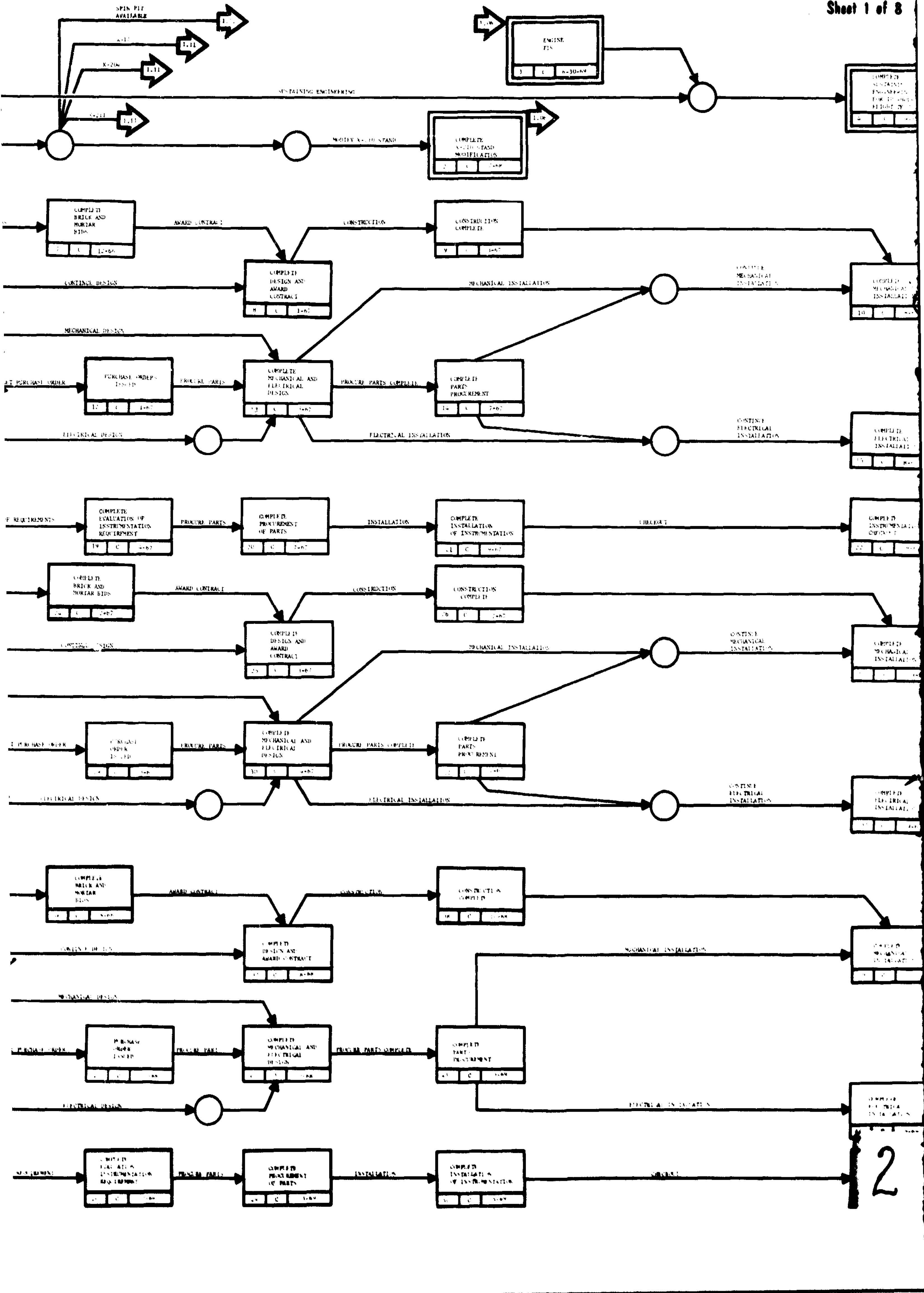


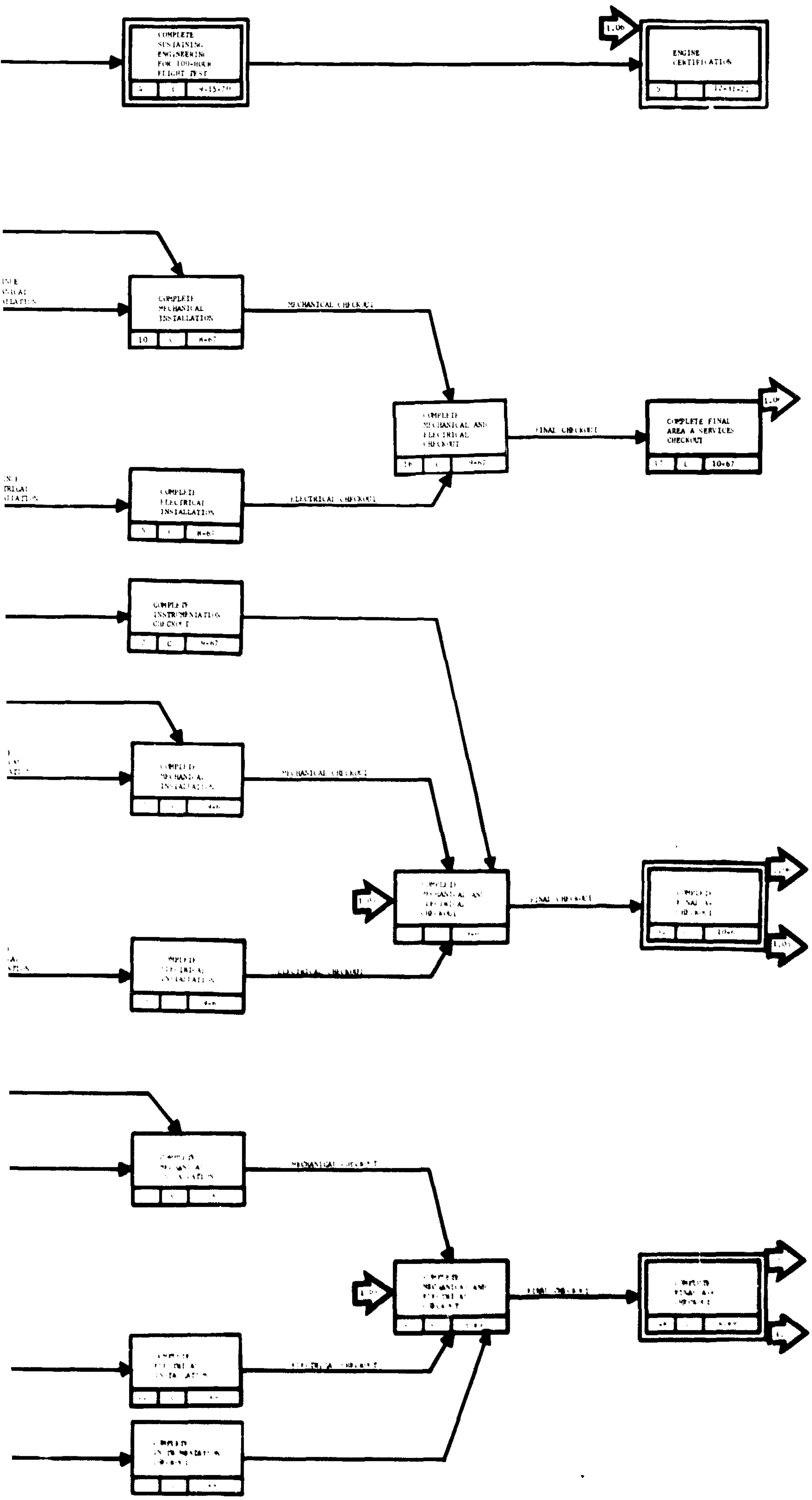
Figure 15. 2.11 Facilities Plan (Sheet 1 of 8)


SPIN PIT AVAILABLE
SUSTAINING ENGINEERING
COMPLETE BRICK AND MORTAR BIDS
AWARD CONTRACT
CONSTRUCTION
CONSTRUCTION COMPLETE
CONTINUE DESIGN
COMPLETE DESIGN AND AWARD CONTRACT
MECHANICAL INSTALLATION
CONTINUE MECHANICAL INSTALLATION
MECHANICAL DESIGN
PURCHASE ORDERS ISSUED
PROCURE PARTS
COMPLETE MECHANICAL AND ELECTRICAL DESIGN
PROCURE PARTS COMPLETE
COMPLETE PARTS PROCUREMENT
ELECTRICAL DESIGN
ELECTRICAL INSTALLATION
CONTINUE ELECTRICAL INSTALLATION
COMPLETE EVALUATION OF INSTRUMENTATION REQUIREMENT
COMPLETE PROCUREMENT OF PARTS
INSTALLATION
COMPLETE INSTALLATION OF INSTRUMENTATION
CHECKOUT

2

2.11 Facilities Plan

Sheet 1 of 8



Event Number	Description and Criteria
1	START [illegible] [illegible]
2	COMPLETE [illegible] STAND [illegible]
3	ENGINE [illegible]
4	COMPLETE [illegible] ENGINEERING [illegible]
5	ENGINE CERTIFICATION Reference [illegible] network [illegible] and criteria.

AREA A STAND SERVICES

Event Number	Description and Criteria
6	START TO OBTAIN BIDS Prepare drawings, specifications [illegible]
	COMPLETE [illegible]
	COMPLETE [illegible] AND AWARD [illegible]
	CONSTRUCTION COMPLETE [illegible]
	COMPLETE MECHANICAL INSTALLATION [illegible]
	[illegible]

3

EVENT DICTIONARY
[illegible] FACILITIES PLAN

Description and Criteria

[illegible]

AREA A STAND SERVICES

Description and Criteria

START TO OBTAIN BIDS

[illegible]

A-[illegible] SEA LEVEL ENGINE DEVELOPMENT STAND

Event Number	Description and Criteria
[illegible]	**START EVALUATION OF REQUIREMENT** Determine what [illegible] equipment is needed and how it operates to meet operating conditions.
[illegible]	**COMPLETE EVALUATION OF INSTRUMENTATION REQUIREMENT** Determine what instrumentation equipment is needed [illegible]
	COMPLETE PROCUREMENT OF PART [illegible]
	COMPLETE INSTALLATION OF INSTRUMENTATION [illegible]
	[illegible]
	START TO OBTAIN BIDS [illegible]
	COMPLETE BRICK AND MORTAR [illegible]
	[illegible]
	COMPLETE MECHANICAL INSTALLATION [illegible]

A-6 SEA LEVEL ENGINE PROTOTYPE STAND

Event Number	Description and Criteria
[illegible]	START TO OBTAIN BIDS Prepare drawings, specifications [illegible]
[illegible]	**COMPLETE BRICK AND MORTAR BIDS** [illegible]
	[illegible]
[illegible]	CONSTR[illegible] Prepare [illegible]
	[illegible]
	COMPLETE ELECTRICAL INSTALLATION [illegible]

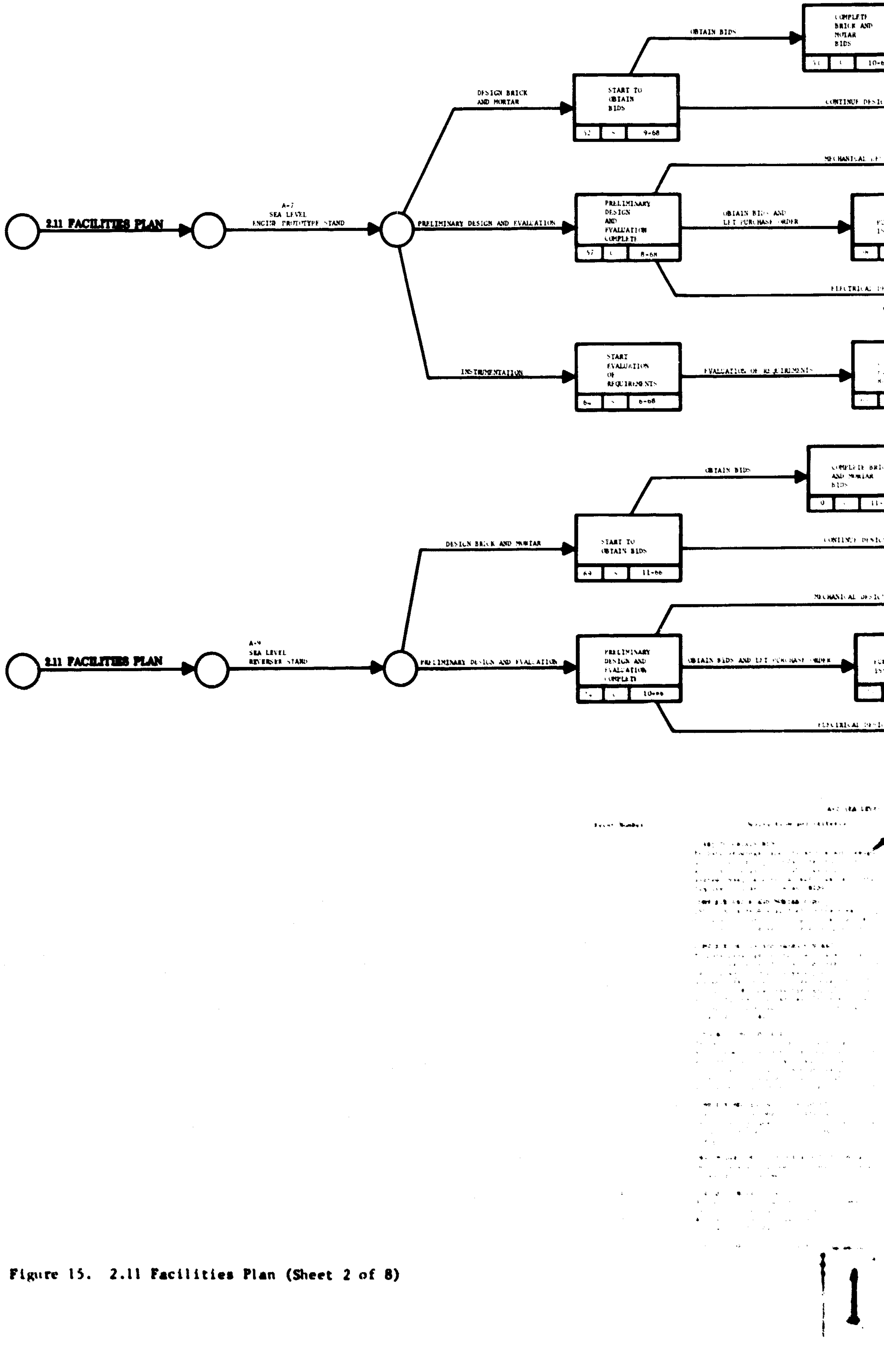
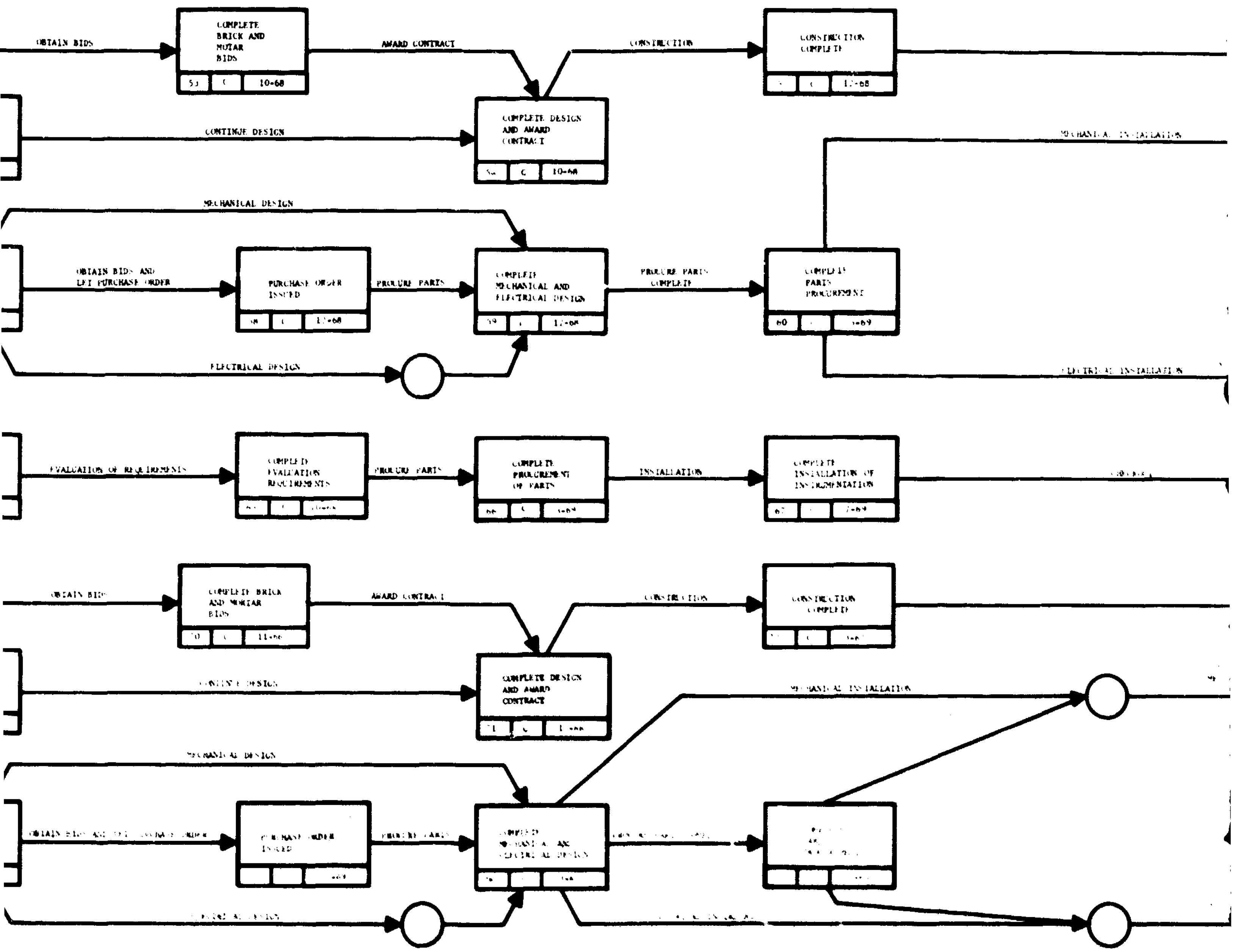


Figure 15. 2.11 Facilities Plan (Sheet 2 of 8)

Sheet 2 of 8



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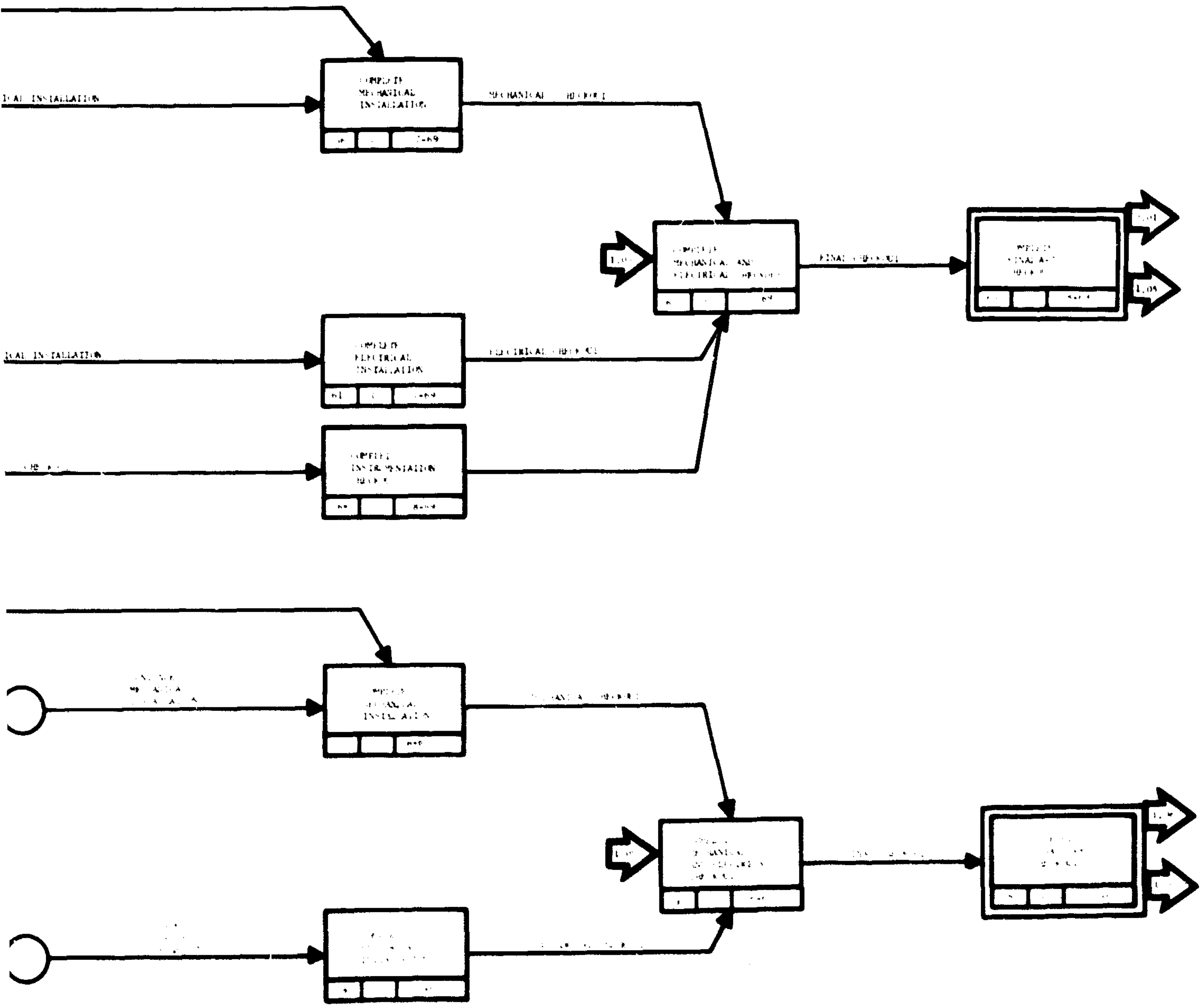


MECHANICAL INSTALLATION
ELECTRICAL INSTALLATION
INSTRUMENTATION
1.09

3

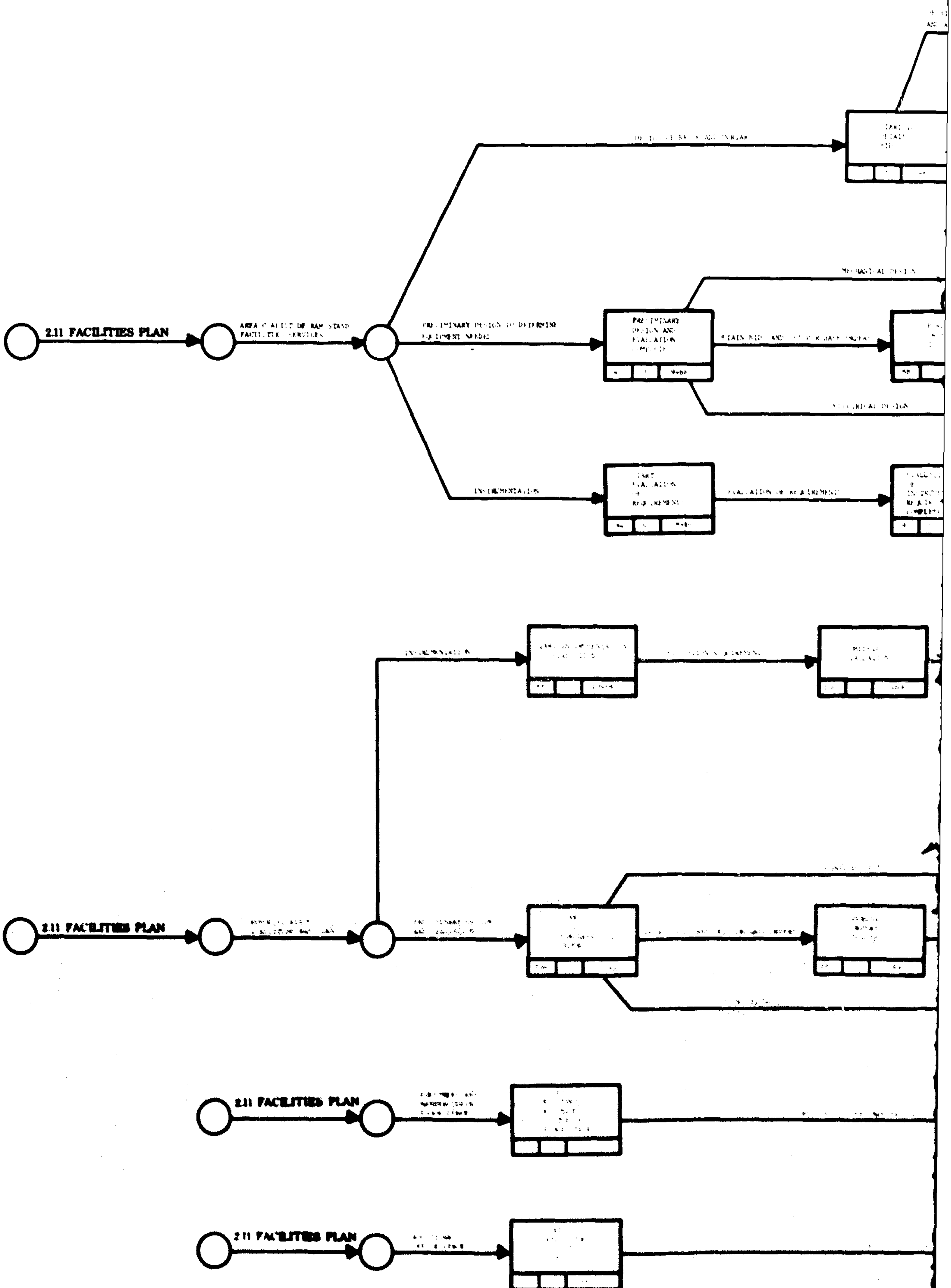
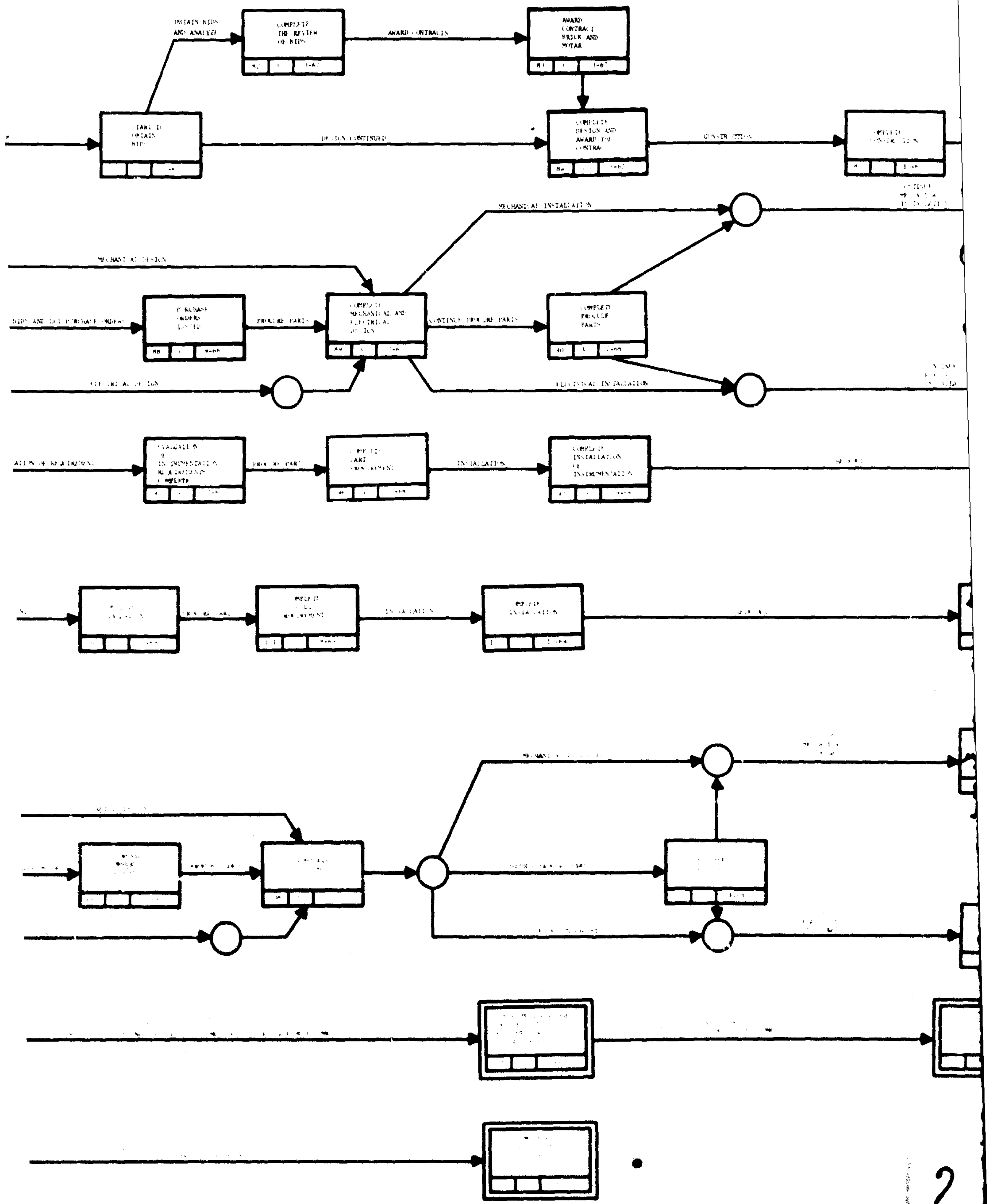


Figure 15. 2.11 Facilities Plan (Sheet 3 of 8)

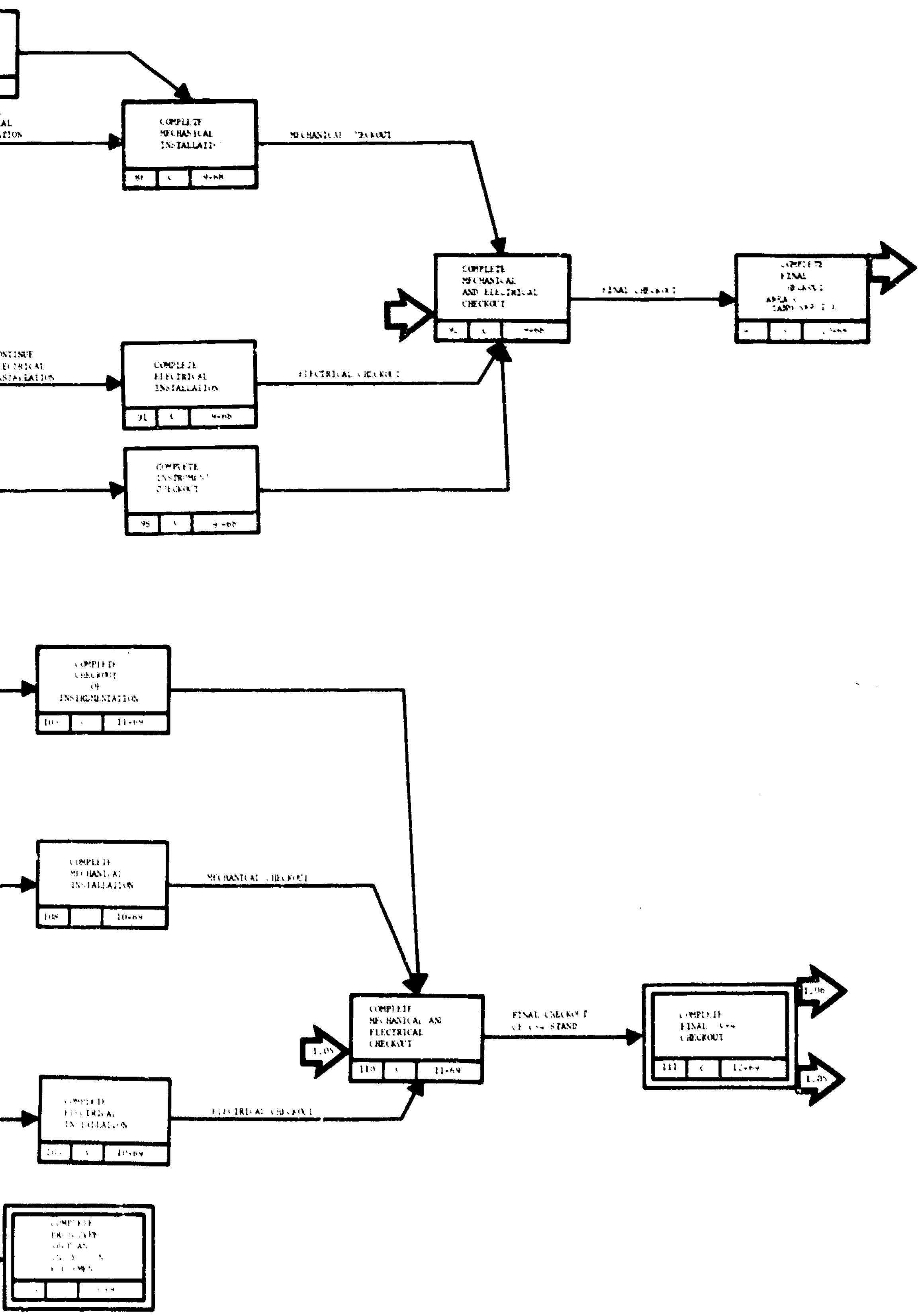


OBTAIN BIDS AND ANALYZE
COMPLETE THE REVIEW OF BIDS
AWARD CONTRACTS
AWARD CONTRACT BRICK AND MOTAR
DESIGN CONTINUED
COMPLETE DESIGN AND AWARD THE CONTRACT
CONSTRUCTION
MECHANICAL INSTALLATION
MECHANICAL DESIGN
BIDS AND LET PURCHASE ORDERS
PURCHASE ORDERS ISSUED
PROCURE PARTS
COMPLETE MECHANICAL AND ELECTRICAL DESIGN
CONTINUE PROCURE PARTS
COMPLETE PROCURE PARTS
ELECTRICAL DESIGN
ELECTRICAL INSTALLATION
INSTALLATION
COMPLETE INSTALLATION OF INSTRUMENTATION

2

2.11 Facilities Plan

Sheet 3 of 8



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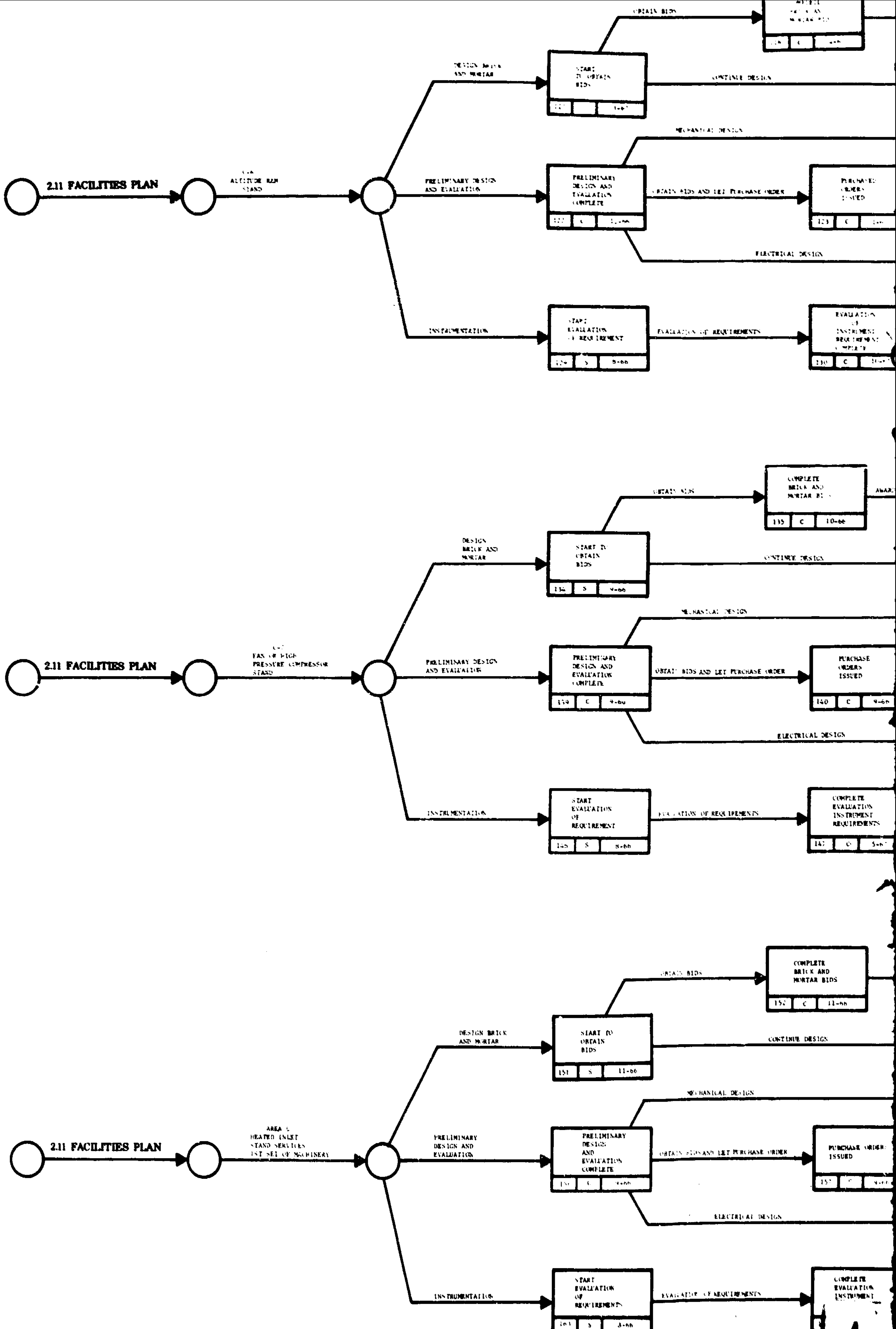
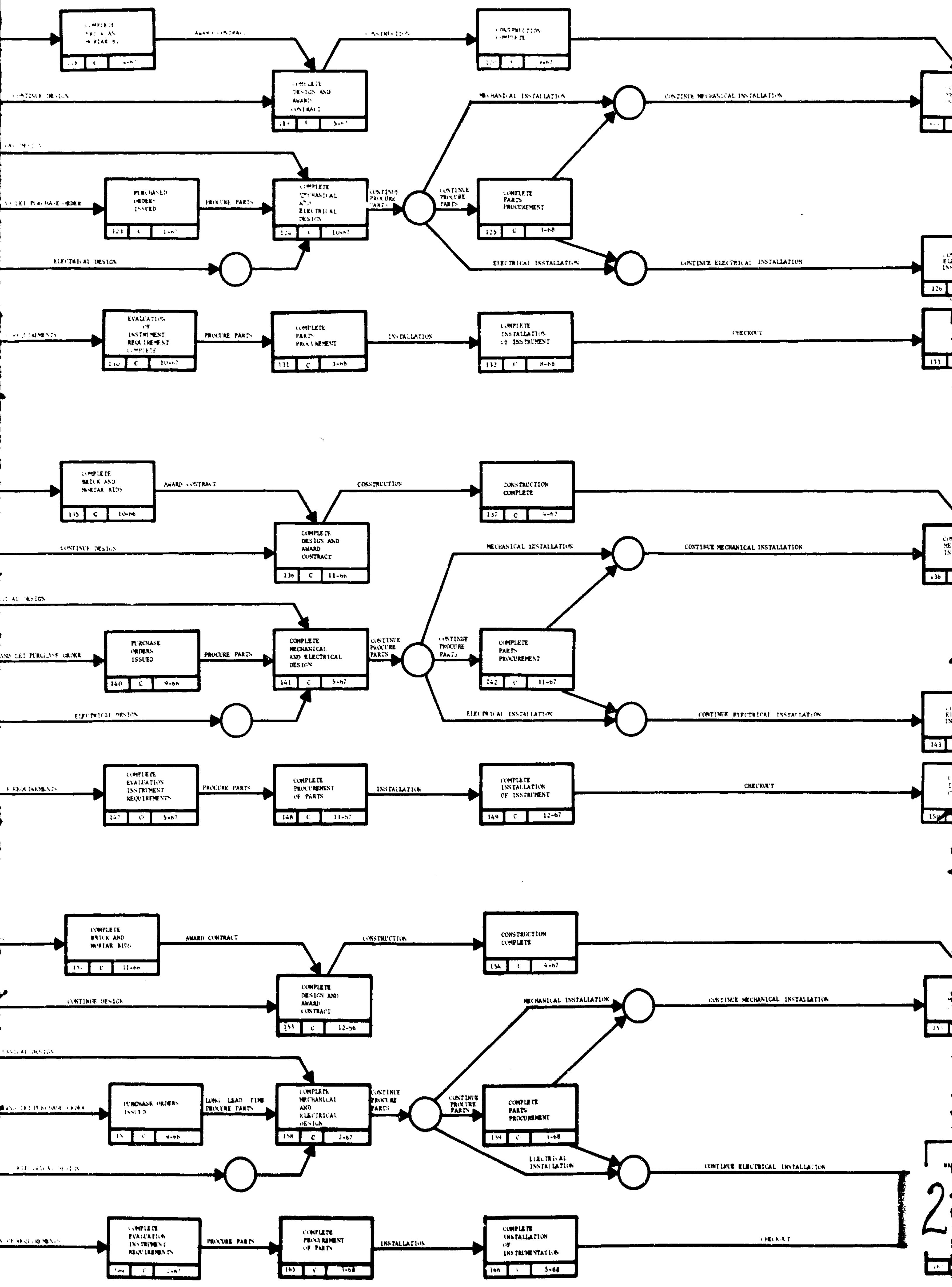
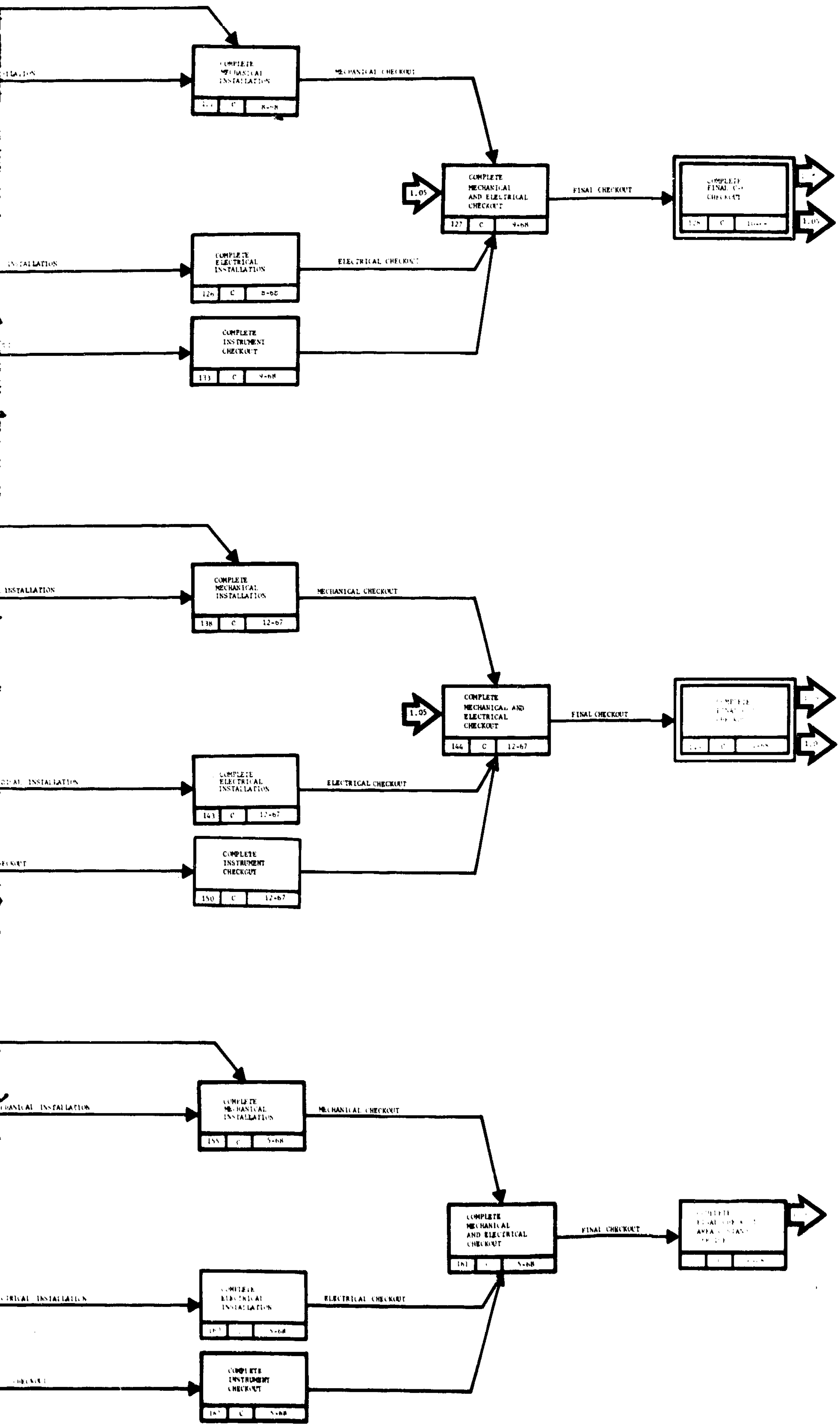


Figure 15. 2.11 Facilities Plan (Sheet 4 of 8)



COMPLETE BRICK AND MORTAR BIDS
AWARD CONTRACT
CONSTRUCTION
CONSTRUCTION COMPLETE
COMPLETE DESIGN AND AWARD CONTRACT
CONTINUE DESIGN
MECHANICAL INSTALLATION
CONTINUE MECHANICAL INSTALLATION
PURCHASE ORDERS ISSUED
PROCURE PARTS
COMPLETE MECHANICAL AND ELECTRICAL DESIGN
CONTINUE PROCURE PARTS
COMPLETE PARTS PROCUREMENT
ELECTRICAL DESIGN
ELECTRICAL INSTALLATION
CONTINUE ELECTRICAL INSTALLATION
EVALUATION OF INSTRUMENT REQUIREMENT COMPLETE
INSTALLATION
COMPLETE INSTALLATION OF INSTRUMENT
CHECKOUT
123 C 1-67
124 C 10-67
125 C 3-68
126
130 C 10-67
131 C 3-68
132 C 8-68
133
135 C 10-66
136 C 11-66
137 C 4-67
138
140 C 9-66
141 C 5-67
142 C 11-67
143
147 C 5-67
148 C 11-67
149 C 12-67
150
COMPLETE EVALUATION INSTRUMENT REQUIREMENTS
COMPLETE PROCUREMENT OF PARTS
155 C 11-66
156 C 4-67
153 C 12-66
LONG LEAD TIME PROCURE PARTS
158 C 2-67
159 C 3-68
COMPLETE INSTALLATION OF INSTRUMENTATION
165 C 3-68
166 C 3-68
2



ALTITUDE RAM STAND

Event Number

[illegible] ALTITUDE RAM STAND

Event Number	Description and Criteria
[illegible]	START TO OBTAIN BIDS Prepare drawings, specifications and design for basic structures, site, foundations, supports, air [illegible] system, scrubbers, basic utilities such as fire water, potable water, etc., cooling water system, basic electrical services, air heater and other services required. Start to obtain BIDS.
[illegible]	COMPLETE BRICK AND MORTAR BIDS Obtain bids from qualified contractors to construct brick and mortar according to designs. Review and analyze bids as furnished by bidders.
[illegible]	COMPLETE DESIGN AND AWARD CONTRACT Prepare drawings, specifications and designs for basic structures, site, foundations, supports, air and gas system, scrubbers, compressor exhausters and heaters, basic utilities such as fire water, potable water, etc., cooling water system, basic electrical services, air heater and other services required. Review drawings, specifications and designs to verify that they satisfy the requirements. Issue contract to successful bidder for brick and mortar [illegible]. Receive copy of contract.
[illegible]	CONSTRUCTION COMPLETE Prepare site, build basic structures, foundations for all equipment and supports, and install basic services such as electrical power, water, fuel, air, etc., [illegible] brick and mortar designs. Verify that locations, materials and specifications are in accordance with brick and mortar designs.
[illegible]	COMPLETE MECHANICAL INSTALLATION Install all equipment and systems according to the mechanical designs. Verify that the equipment and systems are installed in accordance with mechanical [illegible]
[illegible]	PRELIMINARY DESIGN AND EVALUATION COMPLETE [illegible]
[illegible]	PURCHASE ORDERS ISSUED [illegible]
[illegible]	COMPLETE MECHANICAL AND ELECTRICAL DESIGN [illegible]
[illegible]	COMPLETE PARTS PROCUREMENT [illegible]
[illegible]	COMPLETE ELECTRICAL INSTALLATION [illegible]
[illegible]	COMPLETE MECHANICAL AND ELECTRICAL CHECKOUT [illegible]
[illegible]	COMPLETE FINAL CHECKOUT [illegible]
[illegible]	START EVALUATION OF REQUIREMENTS [illegible]
[illegible]	COMPLETE EVALUATION INSTRUMENT REQUIREMENTS [illegible]
[illegible]	COMPLETE PROCUREMENT OF PARTS [illegible]
[illegible]	COMPLETE INSTALLATION OF INSTRUMENT [illegible]
[illegible]	COMPLETE INSTRUMENT CHECKOUT [illegible]

C-7 FAN OR HIGH PRESSURE COMPRESSOR STAND

Event Number	Description and Criteria
[illegible]	START TO OBTAIN BIDS Prepare drawings, specifications and design for basic structures, site, foundations, supports, basic utilities such as fire water, potable water, etc., cooling water system, basic electrical services, and other services required. Start to obtain BIDS.
[illegible]	COMPLETE BRICK AND MORTAR BIDS Obtain bids from qualified contractors to construct brick and mortar according to designs. Review and analyze bids as furnished by bidders.
[illegible]	COMPLETE DESIGN AND AWARD CONTRACT Prepare drawings, specifications and designs for basic structures, site, foundations, supports, air and gas system, basic utilities such as fire water, potable water, etc., cooling water system, basic electrical services, and other services required. Review drawings, specifications and designs to verify that they satisfy the requirements. Issue contract to successful bidder for brick and mortar construction. Receive copy of contract.
[illegible]	CONSTRUCTION COMPLETE Prepare site, build basic structures, foundations for all equipment and supports, and install basic services such as electrical power, water, fuel, air, etc., according to brick and mortar designs. Verify that locations, materials and specifications are in accordance with brick and mortar designs.
[illegible]	COMPLETE MECHANICAL INSTALLATION Install all equipment and systems according to the mechanical designs. Verify that the equipment and systems are installed in accordance with mechanical designs.
[illegible]	PRELIMINARY DESIGN AND EVALUATION COMPLETE Determine what equipment is needed and how it operates to satisfy requirements.
[illegible]	PURCHASE ORDERS ISSUED Bid and let Purchase Orders for equipment and parts required for mechanical and electrical installations. Review and analyze bids and receive copies of purchase orders for equipment.
[illegible]	COMPLETE MECHANICAL AND ELECTRICAL DESIGN Prepare drawings, specifications and designs. Review drawings, specifications and designs to verify that they satisfy the requirements.
[illegible]	COMPLETE PARTS PROCUREMENT Procure parts required for completion of mechanical and electrical installations. Receive copies of [illegible] parts.
[illegible]	COMPLETE ELECTRICAL INSTALLATION Install all equipment and systems according to electrical designs. Verify that equipment and systems are installed in accordance with electrical designs.
[illegible]	COMPLETE MECHANICAL AND ELECTRICAL CHECKOUT Simulate various conditions to systems and equipment [illegible] to verify correct operations. Observe operations of systems and equipment.
[illegible]	COMPLETE FINAL CHECKOUT Operate services utilizing all equipment to verify that the required operational conditions are satisfied. Observe operation of services.
[illegible]	START EVALUATION OF REQUIREMENTS [illegible]
[illegible]	COMPLETE EVALUATION INSTRUMENT REQUIREMENTS [illegible]
[illegible]	COMPLETE PROCUREMENT OF PARTS [illegible]
[illegible]	COMPLETE INSTALLATION OF INSTRUMENT [illegible]
[illegible]	COMPLETE INSTRUMENT CHECKOUT [illegible]

AREA C HEATED INLET STAND SERVICES 1ST SET OF MACHINERY

Event Number	Description and Criteria
[illegible]	START TO OBTAIN BIDS Prepare drawings, specifications and design for basic structures, site, foundations, supports, air [illegible] system, compressor exhausters [illegible] water, potable water, etc., cooling water system, basic electrical services, air heater and other services required. Start to obtain BIDS.
[illegible]	COMPLETE BRICK AND MORTAR BIDS [illegible]
[illegible]	COMPLETE DESIGN AND AWARD CONTRACT [illegible]
[illegible]	CONSTRUCTION COMPLETE [illegible]
[illegible]	COMPLETE MECHANICAL INSTALLATION [illegible]
[illegible]	PRELIMINARY DESIGN AND EVALUATION COMPLETE [illegible]
[illegible]	PURCHASE ORDERS ISSUED [illegible]
[illegible]	COMPLETE MECHANICAL AND ELECTRICAL DESIGN [illegible]
[illegible]	COMPLETE PARTS PROCUREMENT [illegible]
[illegible]	COMPLETE ELECTRICAL INSTALLATION [illegible]
[illegible]	COMPLETE MECHANICAL AND ELECTRICAL CHECKOUT [illegible]
[illegible]	COMPLETE FINAL CHECKOUT AREA C [illegible] SERVICES [illegible]
[illegible]	START EVALUATION OF REQUIREMENTS [illegible]
[illegible]	COMPLETE EVALUATION INSTRUMENT REQUIREMENTS [illegible]
[illegible]	COMPLETE PROCUREMENT OF PARTS [illegible]
[illegible]	COMPLETE INSTALLATION OF INSTRUMENT [illegible]
[illegible]	COMPLETE INSTRUMENT CHECKOUT [illegible]

4

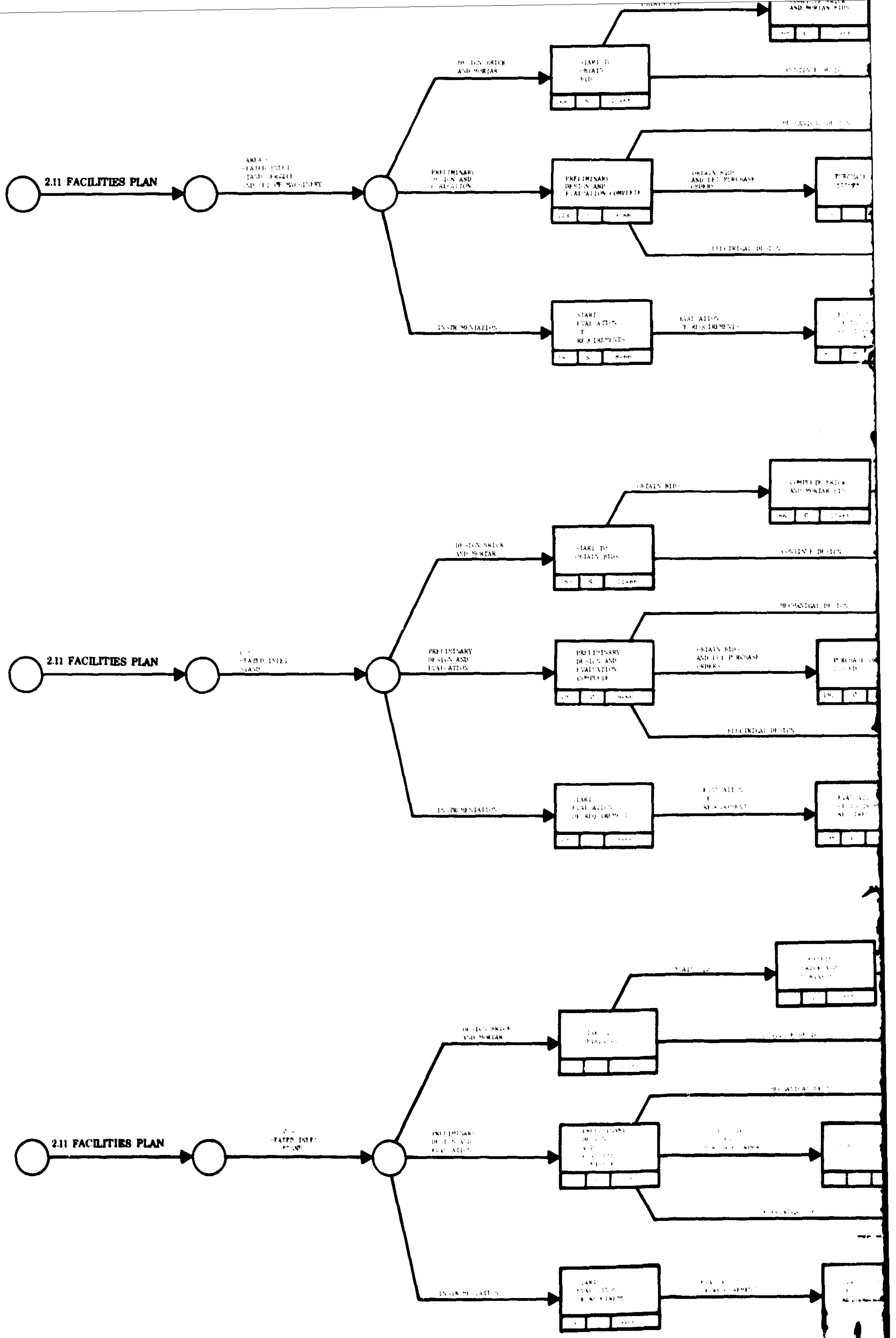
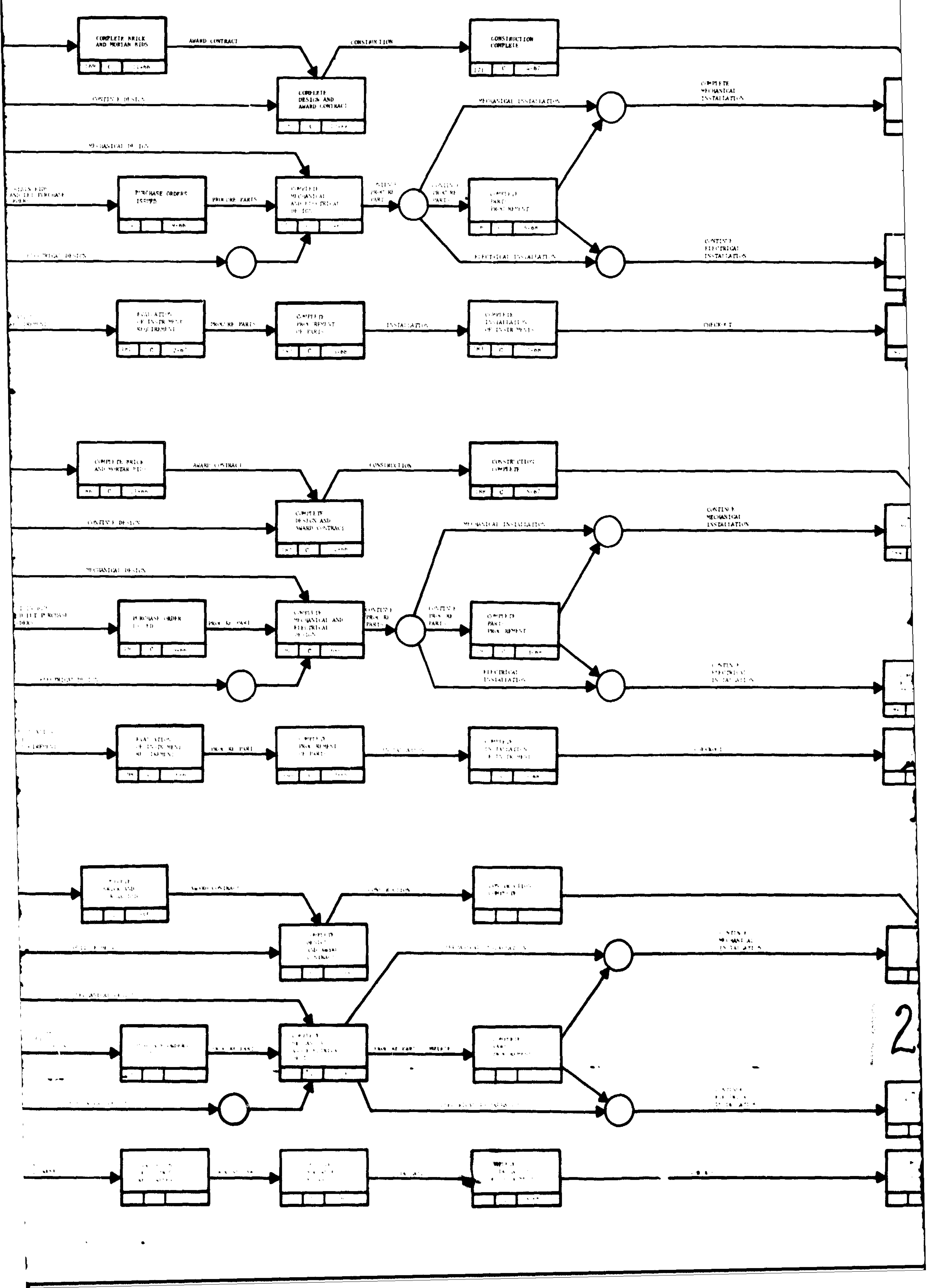
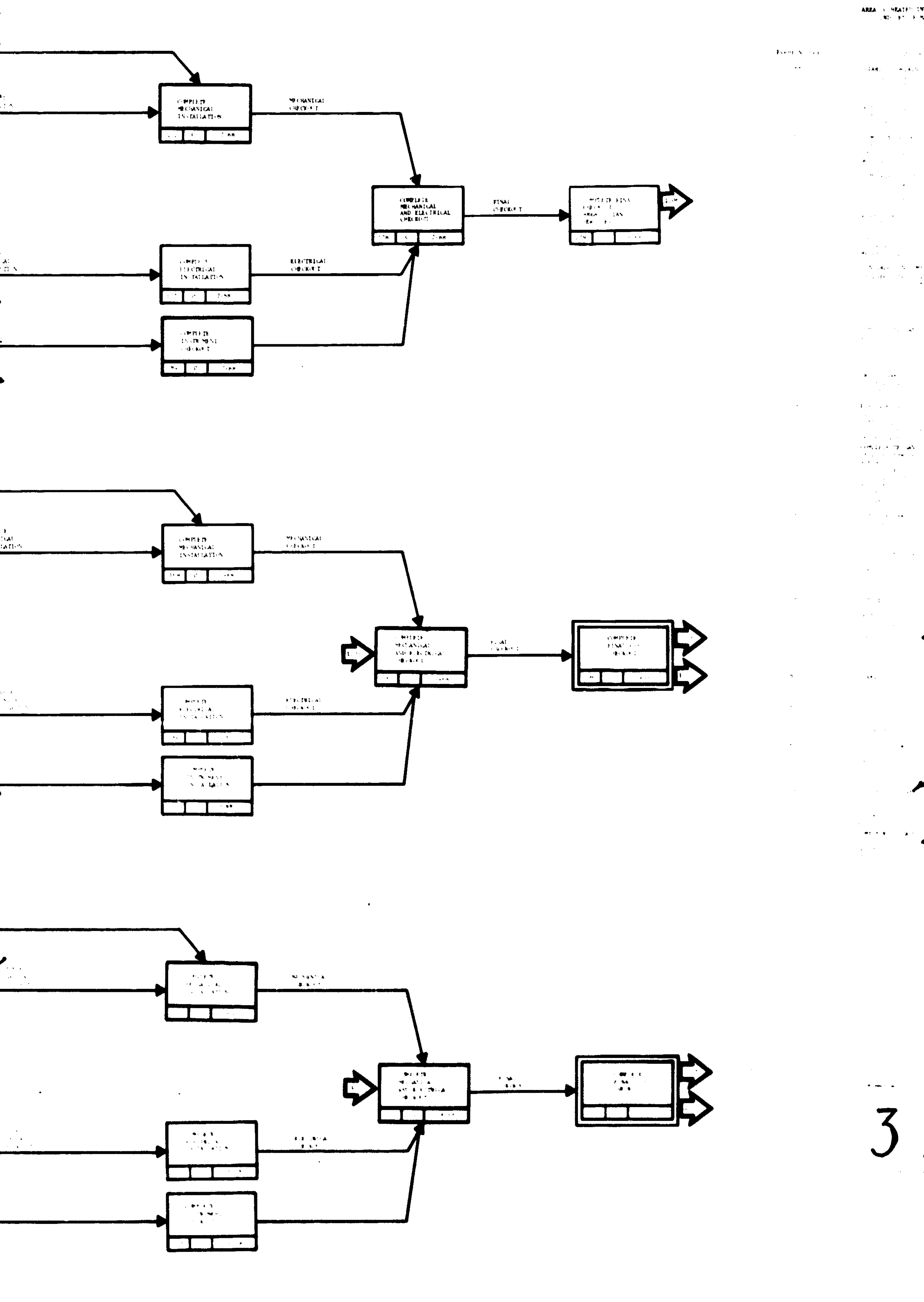


Figure 15. 2.11 Facilities Plan (Sheet 5 of 8)



COMPLETE BRICK AND MORTAR BIDS
AWARD CONTRACT
CONSTRUCTION
CONSTRUCTION COMPLETE
CONTINUE DESIGN
COMPLETE DESIGN AND AWARD CONTRACT
MECHANICAL INSTALLATION
COMPLETE MECHANICAL INSTALLATION
MECHANICAL DESIGN
PURCHASE ORDERS ISSUED
PROCURE PARTS
ELECTRICAL INSTALLATION
CONTINUE ELECTRICAL INSTALLATION
INSTALLATION
CHECKOUT


COMPLETE MECHANICAL INSTALLATION
MECHANICAL CHECKOUT
COMPLETE MECHANICAL AND ELECTRICAL CHECKOUT
FINAL CHECKOUT
COMPLETE ELECTRICAL INSTALLATION
ELECTRICAL CHECKOUT
COMPLETE INSTRUMENT CHECKOUT

AREA C HEATED INLET STAND SERVICES
2ND SET OF MACHINERY

C-N HEATED INLET STAND

C-N HEATED INLET STAND

Event Number	Description and Criteria
	START TO OBTAIN BIDS
	COMPLETE BRICK AND MORTAR BIDS
	COMPLETE DESIGN AND AWARD CONTRACT
	CONSTRUCTION COMPLETE
	COMPLETE MECHANICAL INSTALLATION
	PRELIMINARY DESIGN AND EVALUATION COMPLETE
	PURCHASE ORDER ISSUED
	COMPLETE MECHANICAL AND ELECTRICAL DESIGN

4

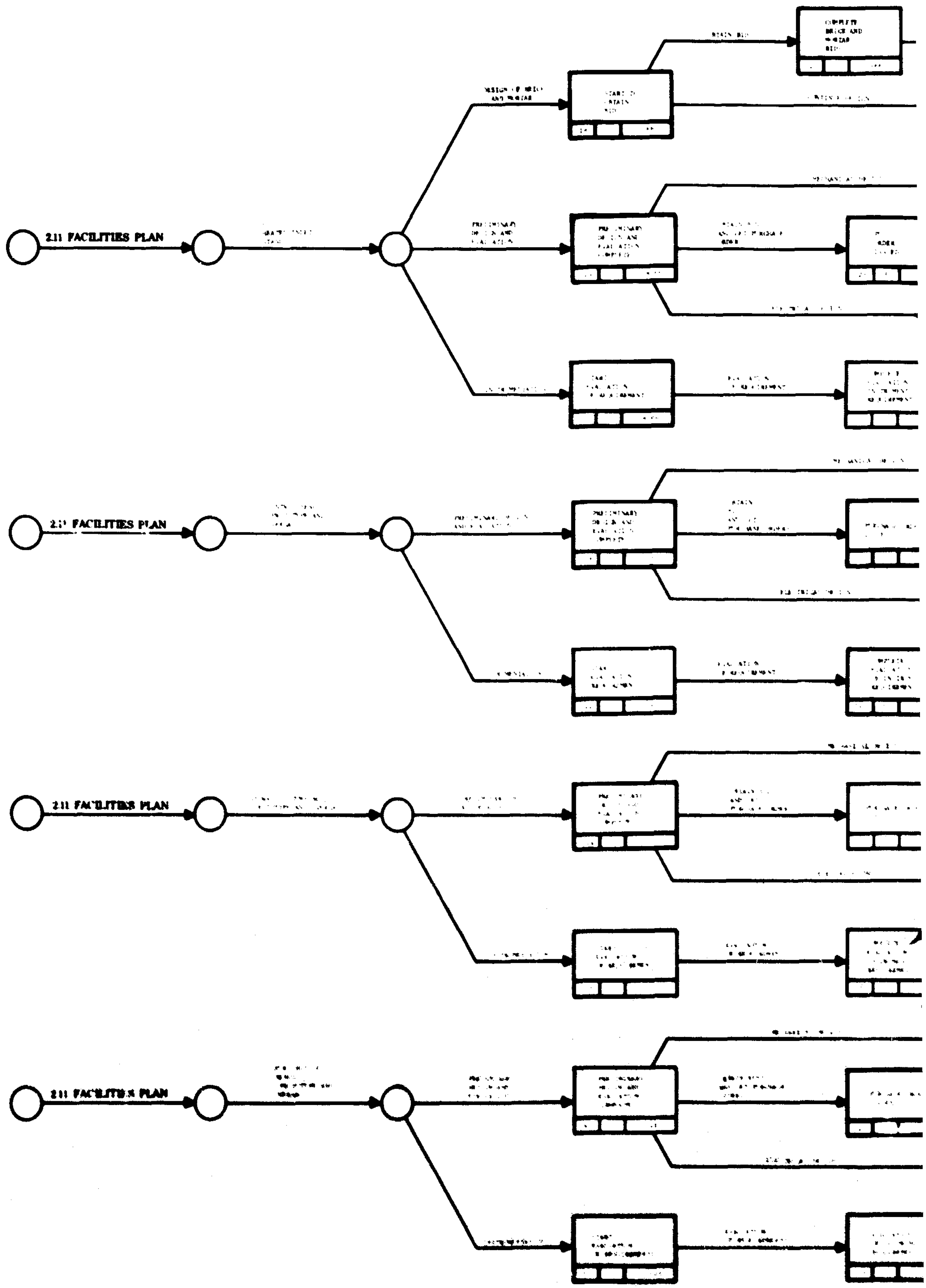
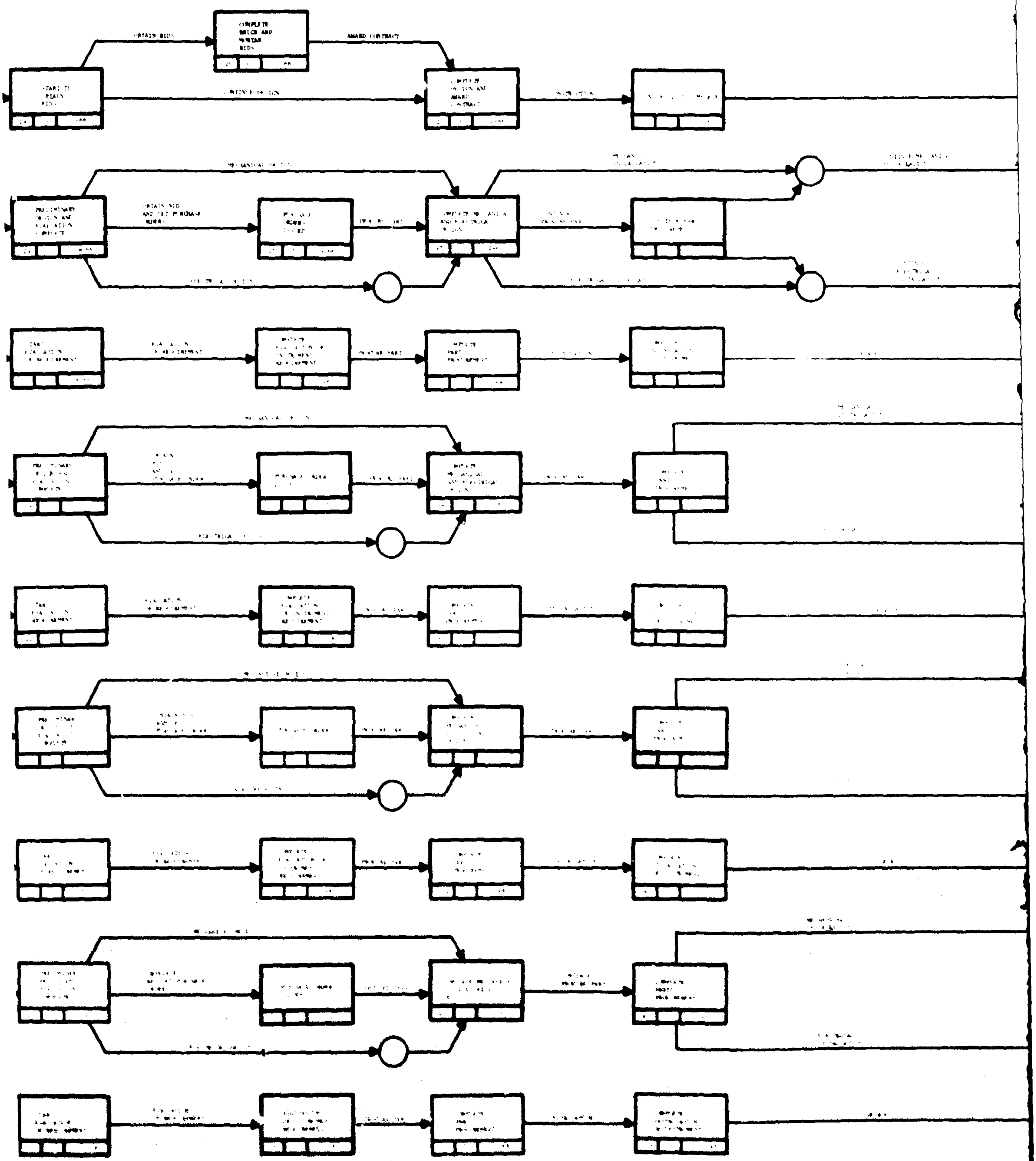
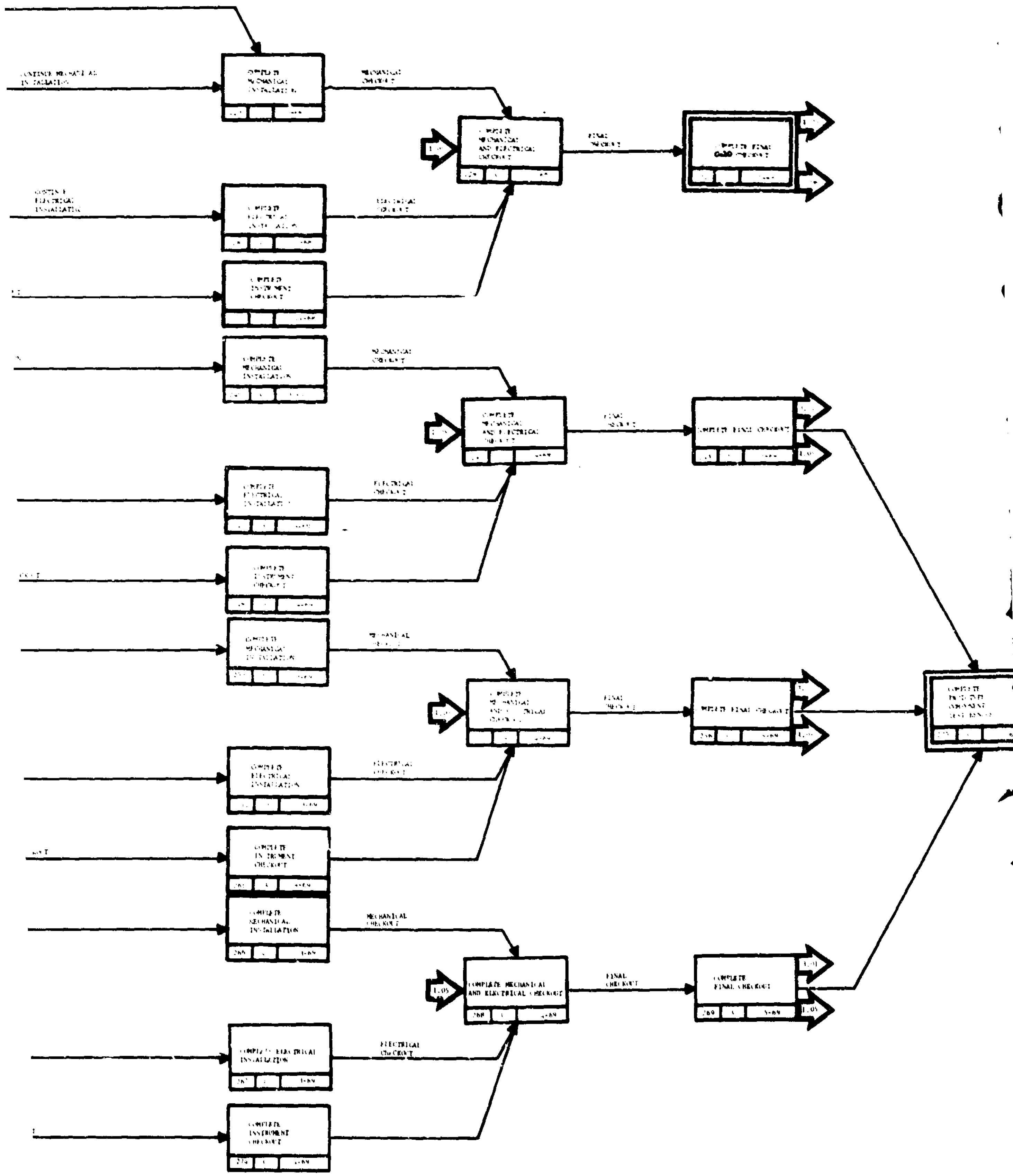


Figure 15. 2.11 Facilities Plan (Sheet 6 of 8)

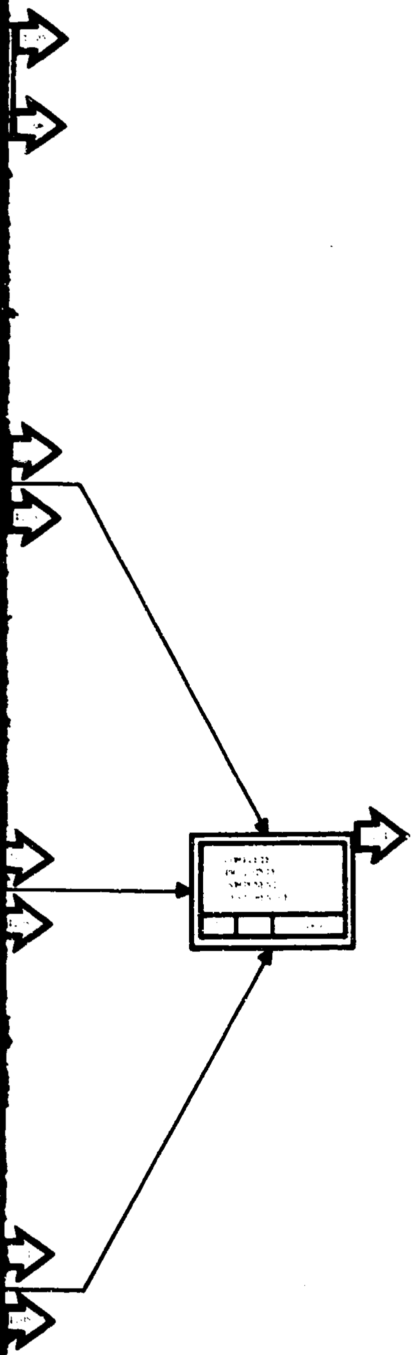


2

2.11 Facilities Plan
Sheet 6 of 8



3



PROTOTYPE COMPONENT TEST BENCHES

[illegible]

COMPLETE MECHANICAL INSTALLATION
[illegible]

COMPLETE ELECTRICAL INSTALLATION
[illegible]

COMPLETE MECHANICAL AND ELECTRICAL CHECKOUT
[illegible]

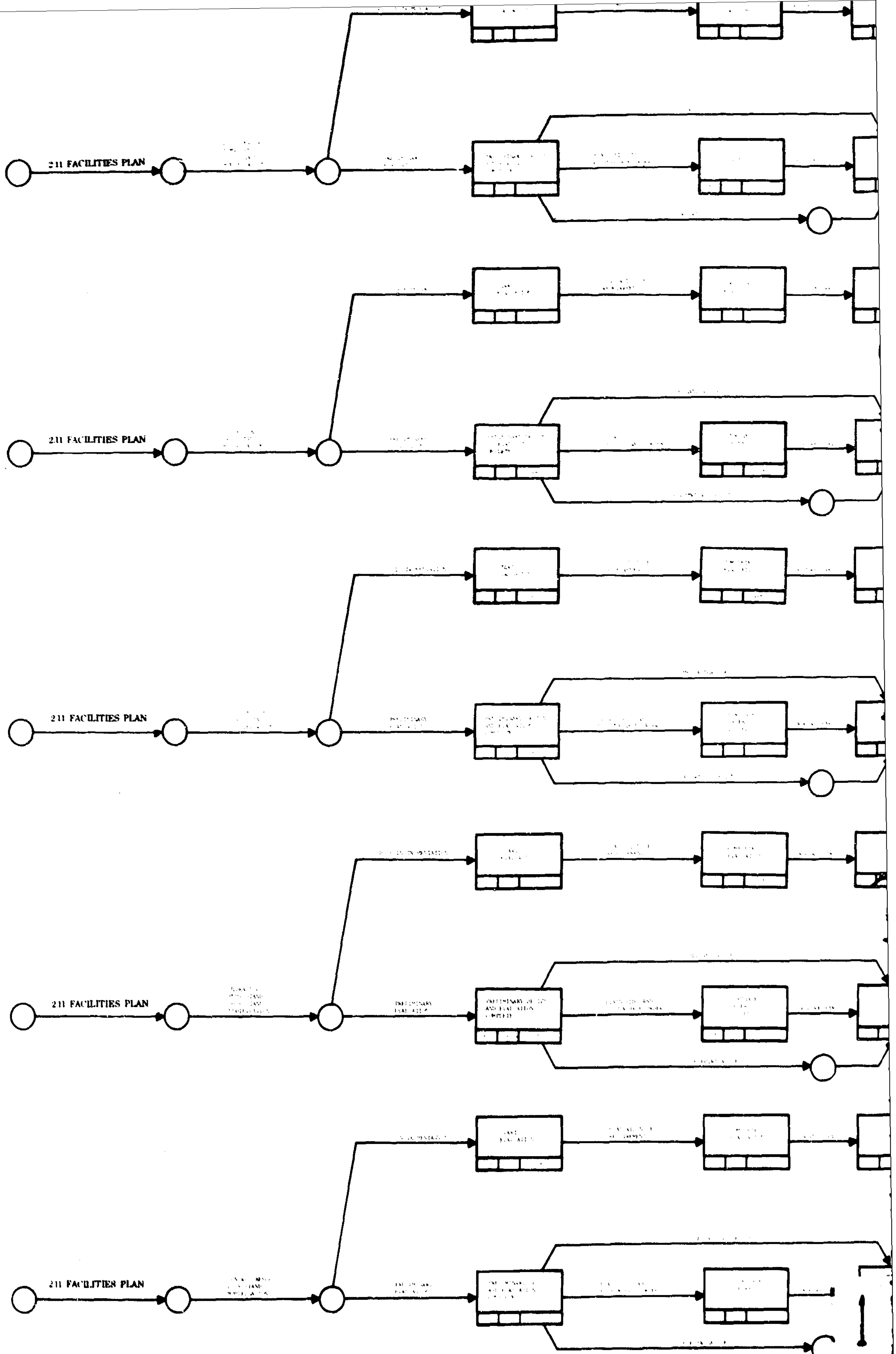
COMPLETE FINAL CHECKOUT
[illegible] equipment

COMPLETE PARTS PROCUREMENT
[illegible] for parts.

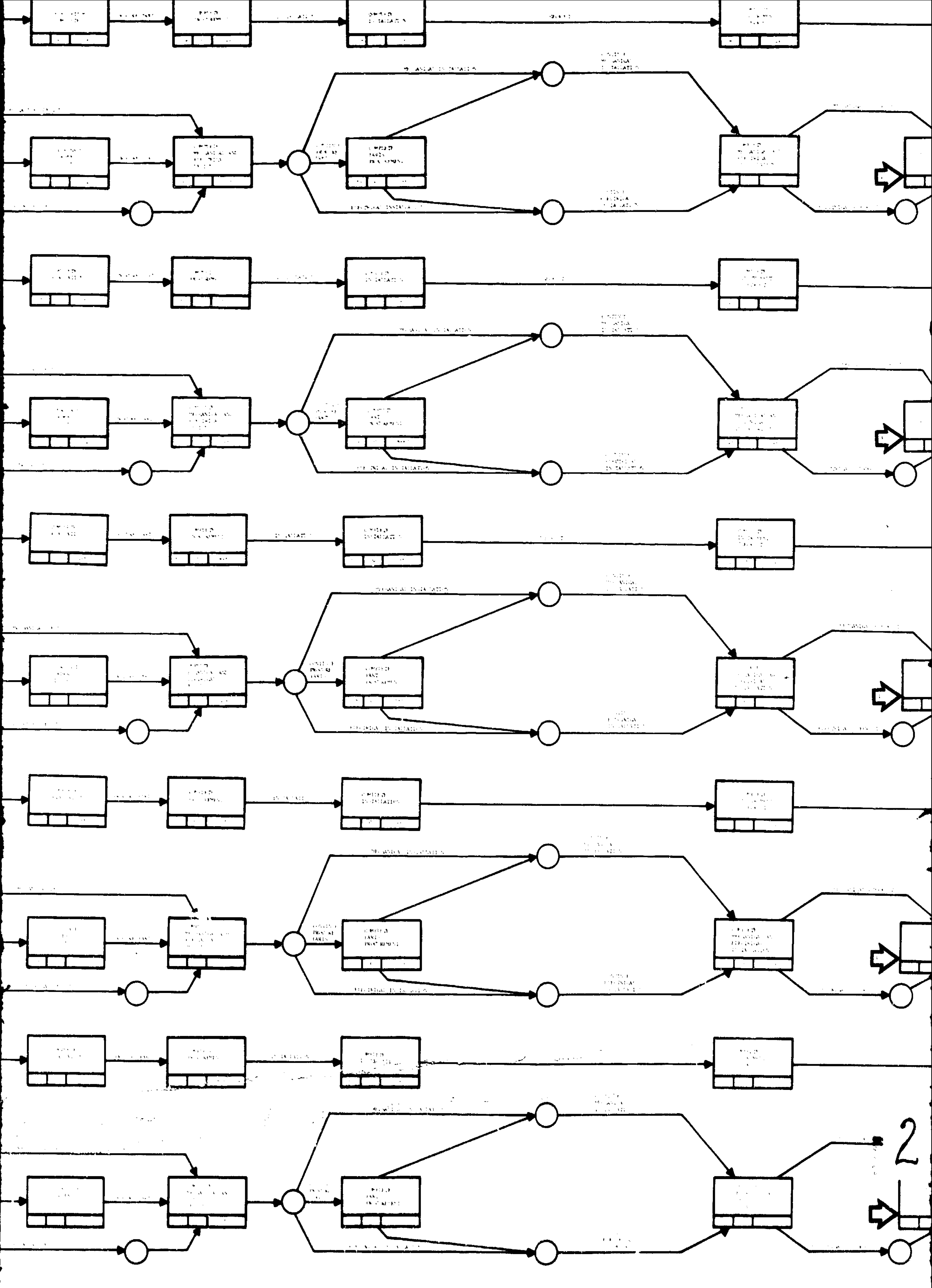
COMPLETE INSTALLATION OF INSTRUMENTS
Install the instrumentation parts and equipment required for operation. [illegible] of instrumentation equipment and parts according to procedures.

COMPLETE INSTRUMENT CHECKOUT
[illegible]

COMPLETE PROTOTYPE COMPONENT TEST BENCHES
Construct and [illegible] control bench, hydraulic pump bench and fuel nozzle bench.



F[illegible] 2.11 Facilities Plan (Sheet 7 of 8)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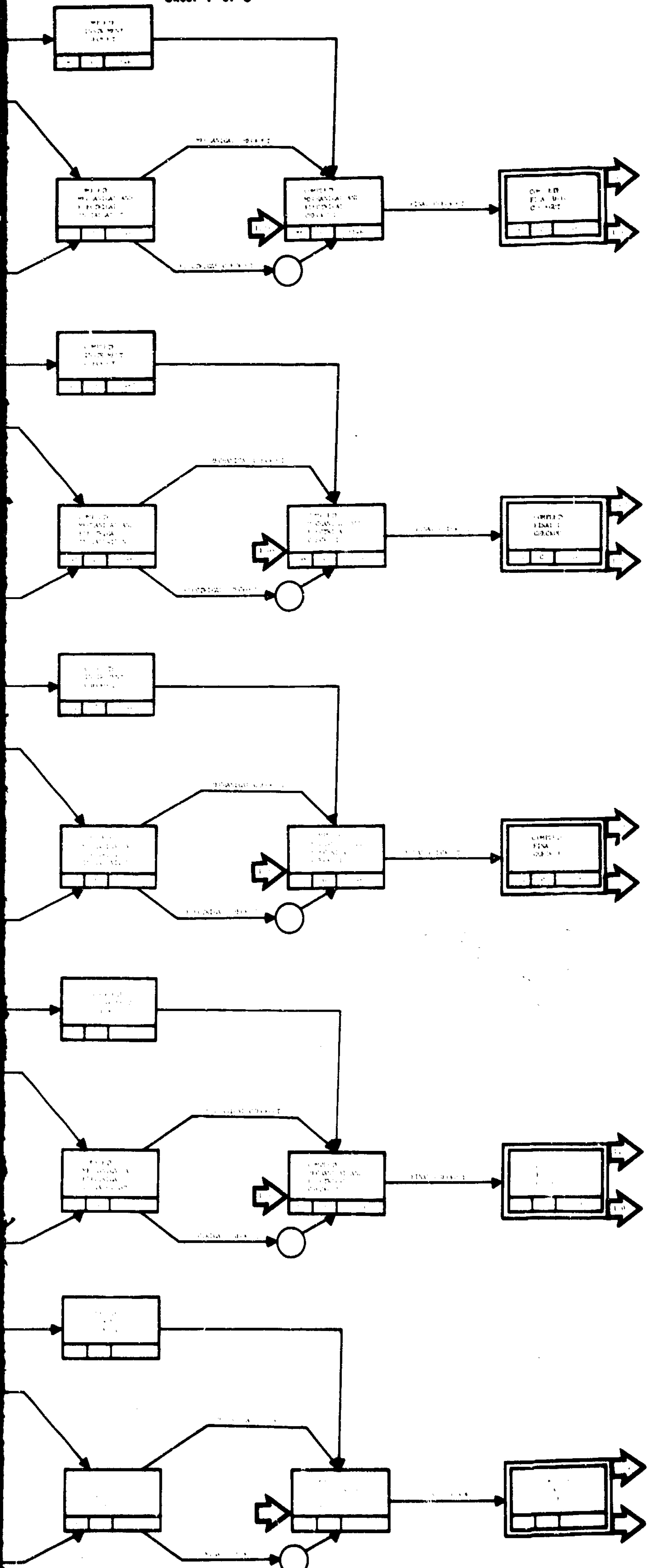

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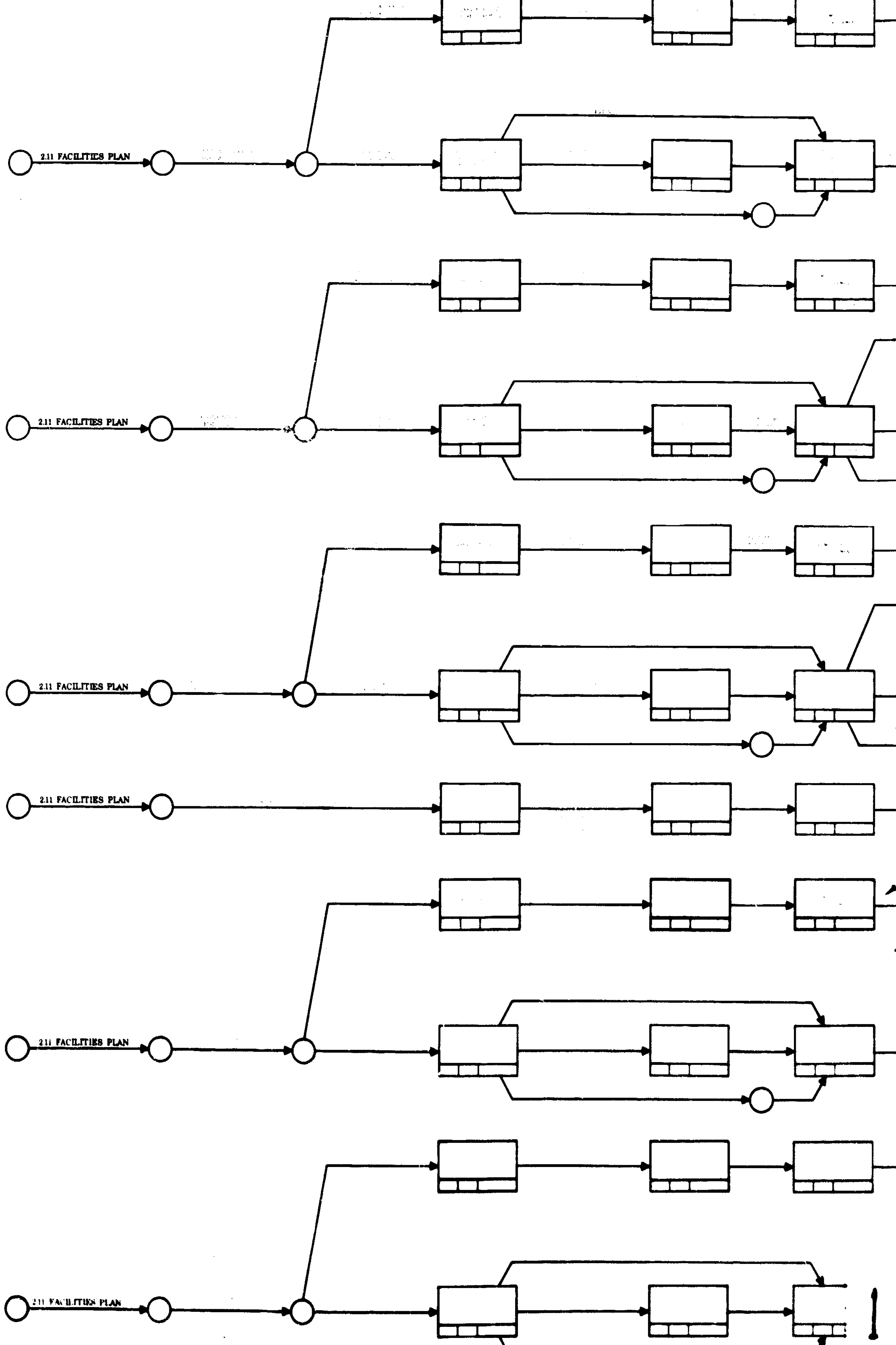
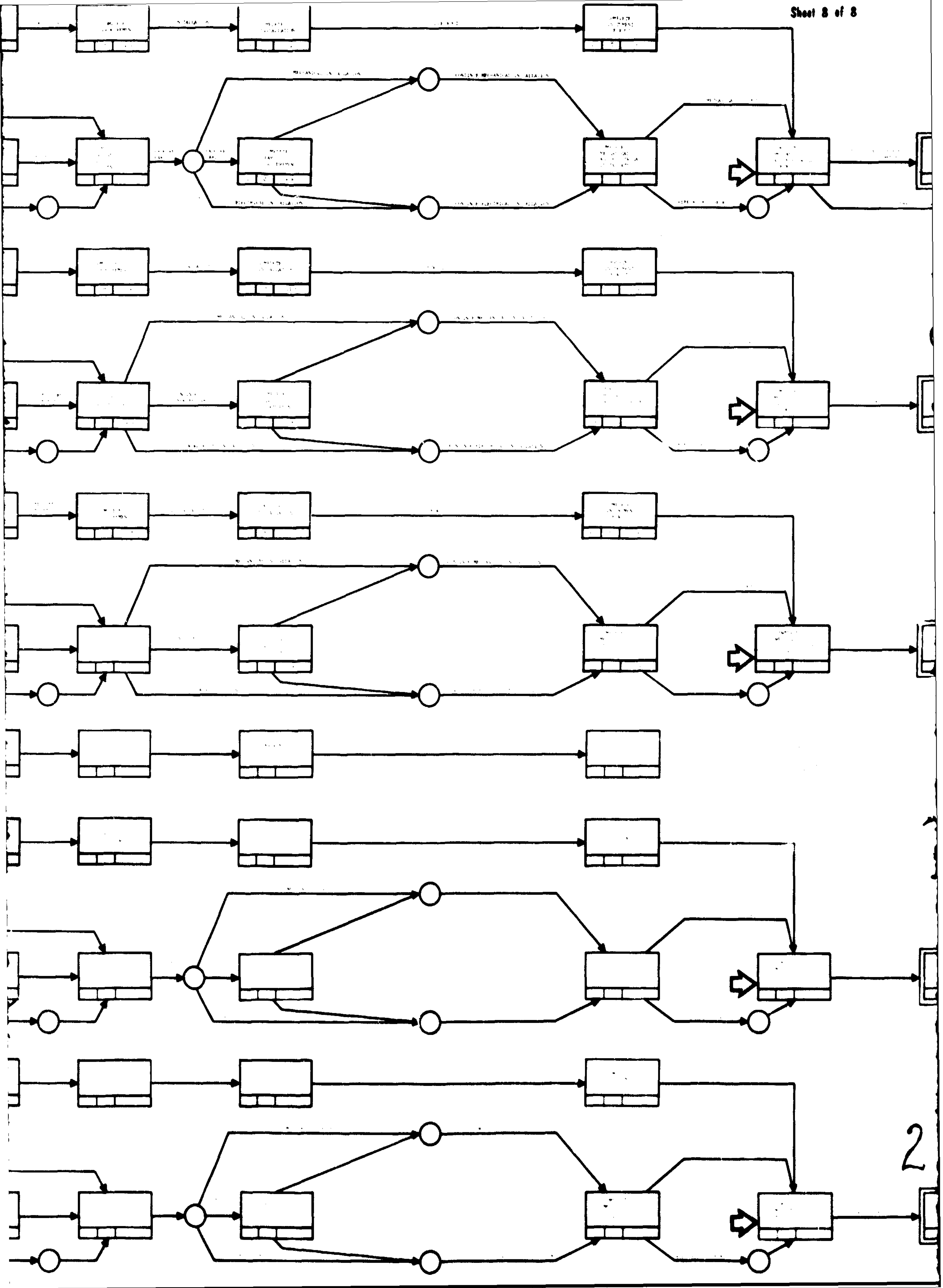
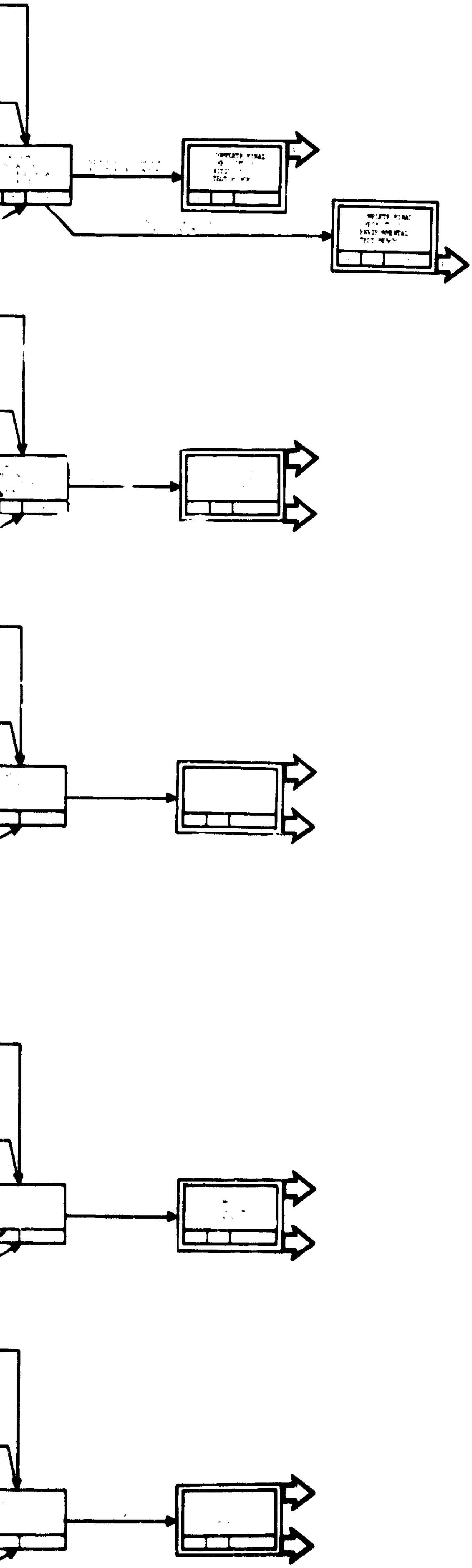

2.11 FACILITIES PLAN
2.11 FACILITIES PLAN
2.11 FACILITIES PLAN
2.11 FACILITIES PLAN
2.11 FACILITIES PLAN
2.11 FACILITIES PLAN





3

4

2.12 COST ANALYSES

Pratt & Whitney Aircraft will provide the following cost functions to support the JTF17 engine program cost requirements during Phase III:

Cost Baseline Report (Reference Volume VI)

A report will be prepared and submitted annually on 15 September for the updated Phase IV and Phase V Cost Baseline Estimate. This report will be presented in accordance with Formats A, B, C and D for Phase IV and Formats A, B, C, D and G for Phase V.

Report of Funding Requirements

An estimate will be prepared annually on 15 September in accordance with Article XVIII of the Contract indicating the maximum allowable costs expected to be incurred in the following fiscal year.

A complete description of cost analyses is presented in Costs, Volume VI, of this proposal.

2.13 PROPOSALS

The Contractor shall submit definitive proposals for subsequent phases as required. The Contractor shall also prepare and submit a firm, detailed production engine specification including appropriate performance warranties. This specification shall include the then-current "production design objectives," defined in Article XV and the preliminary model specification referenced in Exhibit A, as such objectives may have been changed in accordance with Article XVI of this contract. Together with this specification, the Contractor shall submit a detailed statement of such additional warranties and guarantees as the Contractor may then be willing to make.

SECTION III
DELIVERY AND PRODUCT SUPPORT

3.01 GROUND, TAXI, AND FLIGHT TEST ENGINES

During the Phase III program a total of 20 JTF17 engines will be fabricated, acceptance tested, and delivered to the airframe contractor. The first four engines will be delivered prior to completion of engine FTS for ground test use. If required, four additional engines will be delivered for taxi tests in the aircraft program, and it is planned to modify these engines to the FTS configuration for use during the 100-hour Flight Test program. All schedules and charts are based on the use of four taxi test engines in the program.

The major milestones, network chart and event dictionary for the ground, taxi, and flight test engine program are shown in figures 1 and 2, respectively.

A detailed description of the ground, taxi, and flight test engine program is presented in the Test and Certification Plan, Volume III, Report E, and test planning and integration is presented in Test, Volume IV, Report E.

3.01 GROUND, TAXI, AND FLIGHT TEST ENGINE SCHEDULE

FACILITIES

1. SEA LEVEL TEST STANDS
2. AEDC TEST FACILITIES
3. AIRFRAME TEST SITE

MILESTONES

START PHASE III

DELIVER FIRST GROUND TEST ENGINE

DELIVER SECOND GROUND TEST ENGINE

DELIVER THIRD GROUND TEST ENGINE

DELIVER FOURTH GROUND TEST ENGINE

DELIVER FIRST TAXI TEST ENGINE

DELIVER SECOND TAXI TEST ENGINE

DELIVER THIRD TAXI TEST ENGINE

DELIVER FOURTH TAXI TEST ENGINE

ENGINE FTS

DELIVER FIRST PROTOTYPE ENGINE

DELIVER SECOND PROTOTYPE ENGINE

DELIVER THIRD PROTOTYPE ENGINE

DELIVER FOURTH PROTOTYPE ENGINE

DELIVER FIFTH PROTOTYPE ENGINE

DELIVER SIXTH PROTOTYPE ENGINE

DELIVER SEVENTH PROTOTYPE ENGINE

DELIVER EIGHTH PROTOTYPE ENGINE

DELIVER NINTH PROTOTYPE ENGINE

DELIVER TENTH PROTOTYPE ENGINE

DELIVER ELEVENTH PROTOTYPE ENGINE

DELIVER TWELFTH PROTOTYPE ENGINE

DELIVER FIRST REFURBISHED TAXI TEST ENGINE

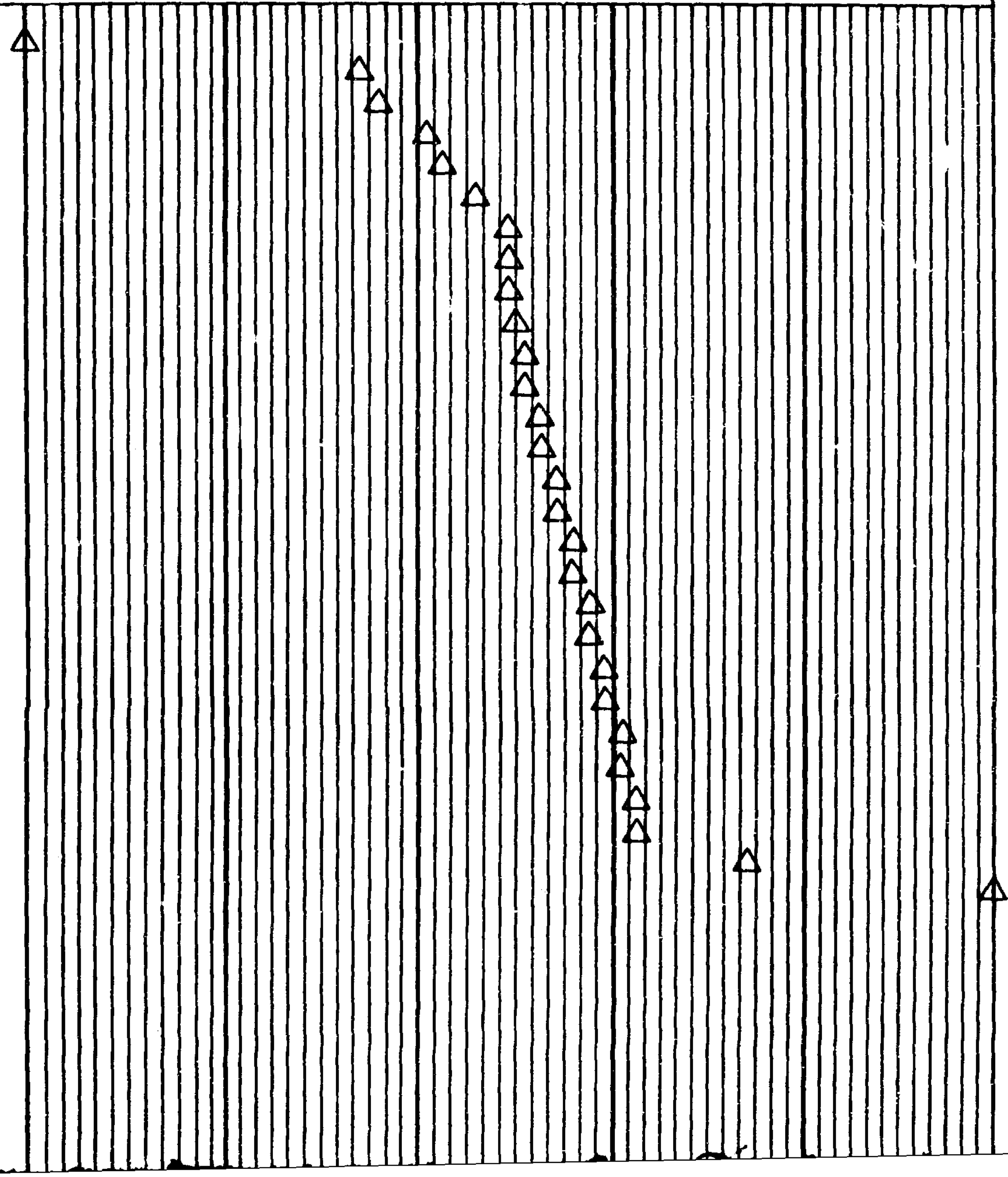
DELIVER SECOND REFURBISHED TAXI TEST ENGINE

DELIVER THIRD REFURBISHED TAXI TEST ENGINE

DELIVER FOURTH REFURBISHED TAXI TEST ENGINE

COMPLETE 100-HR FLIGHT TEST PROGRAM

ENGINE CERTIFICATION



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VH

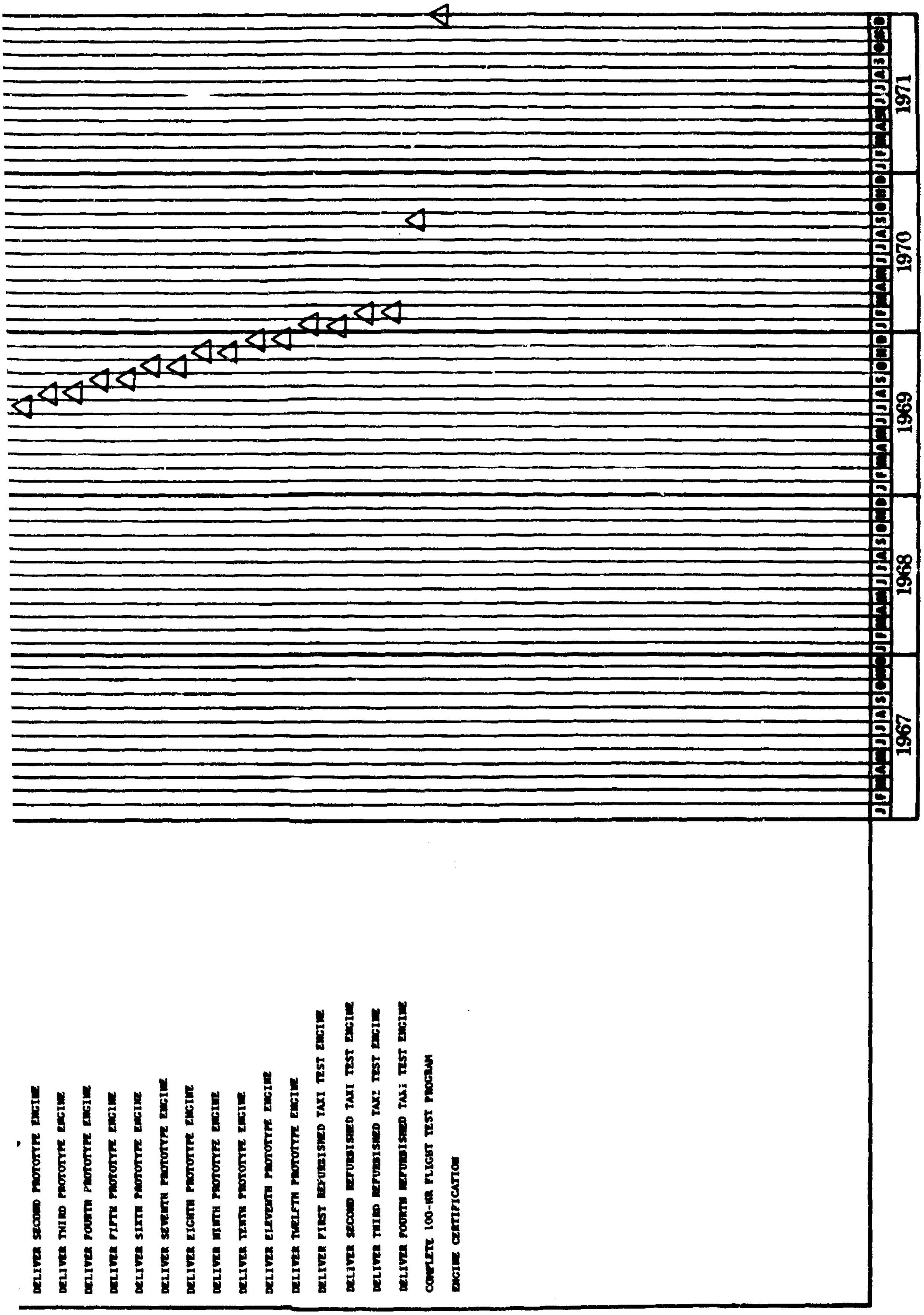
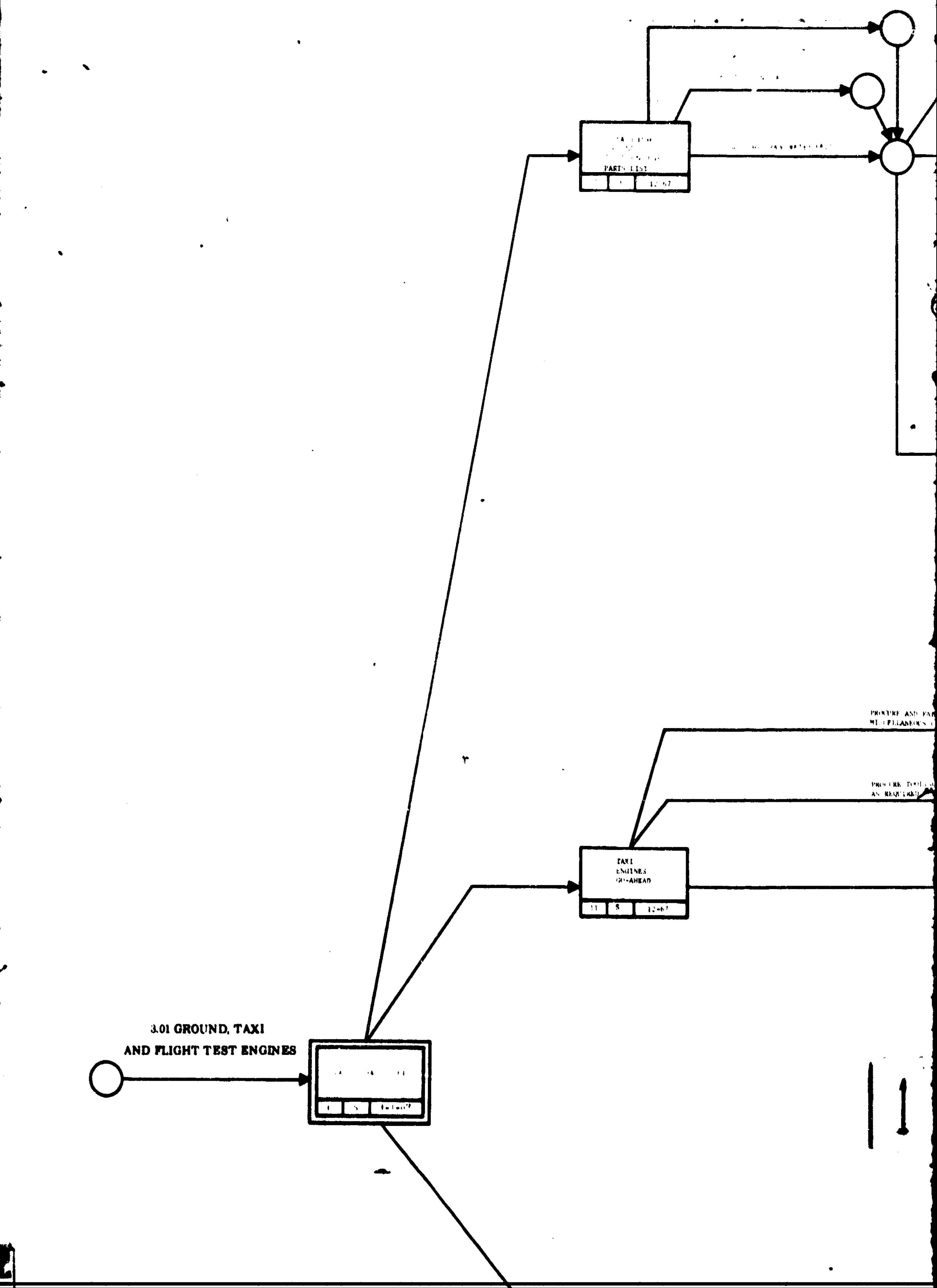
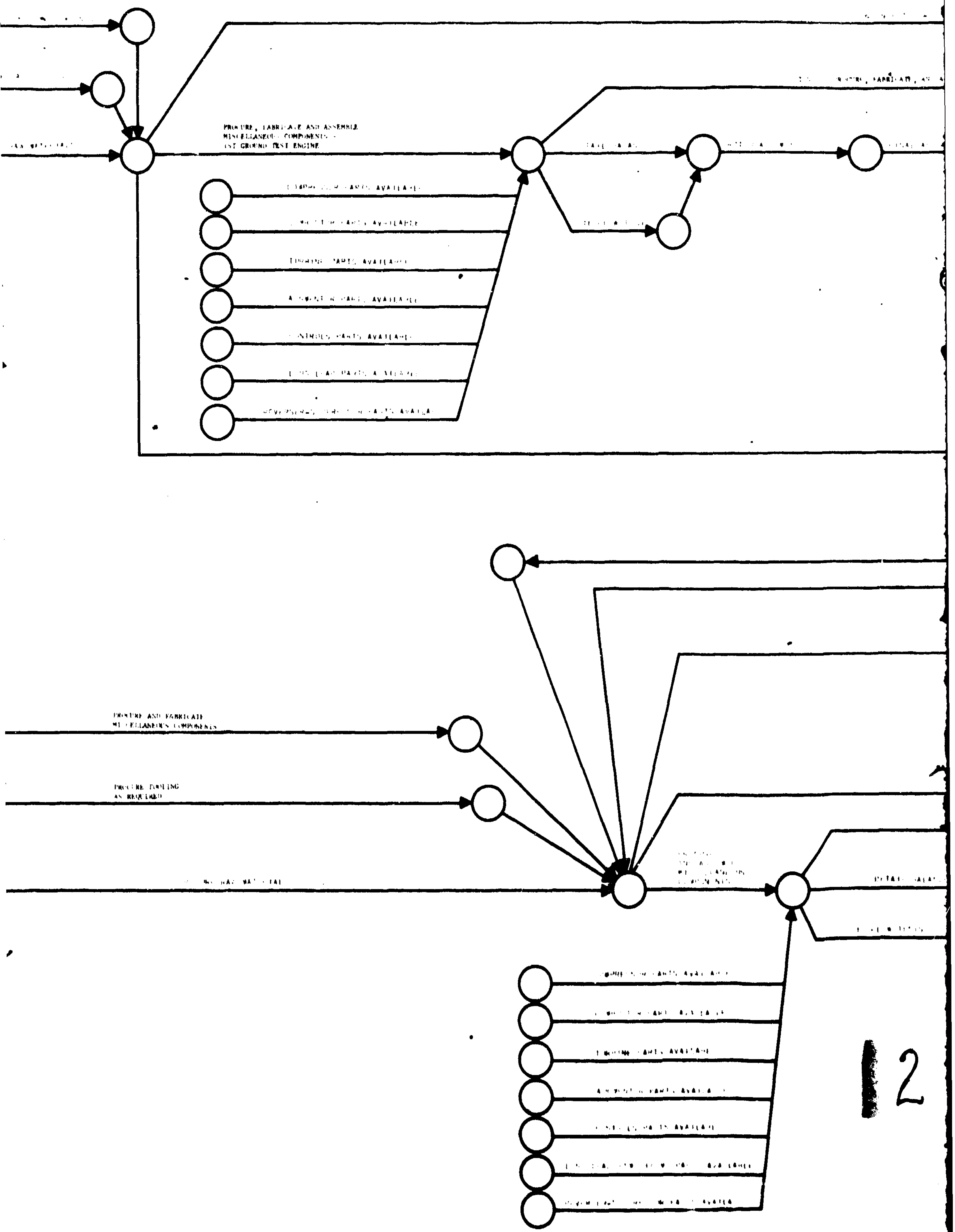


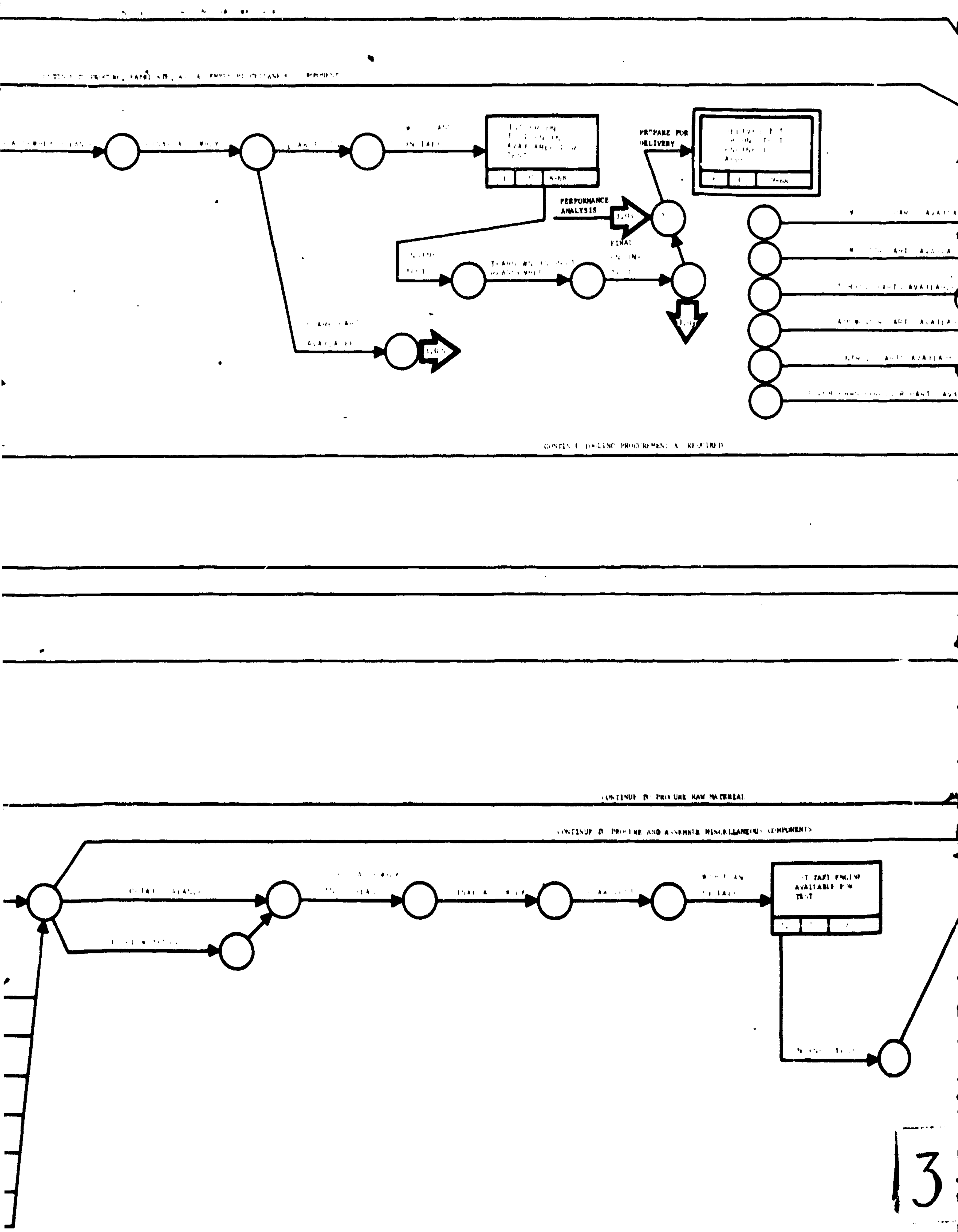
Figure 1. 3.01 Ground, Taxi, and Flight Test Engines

12

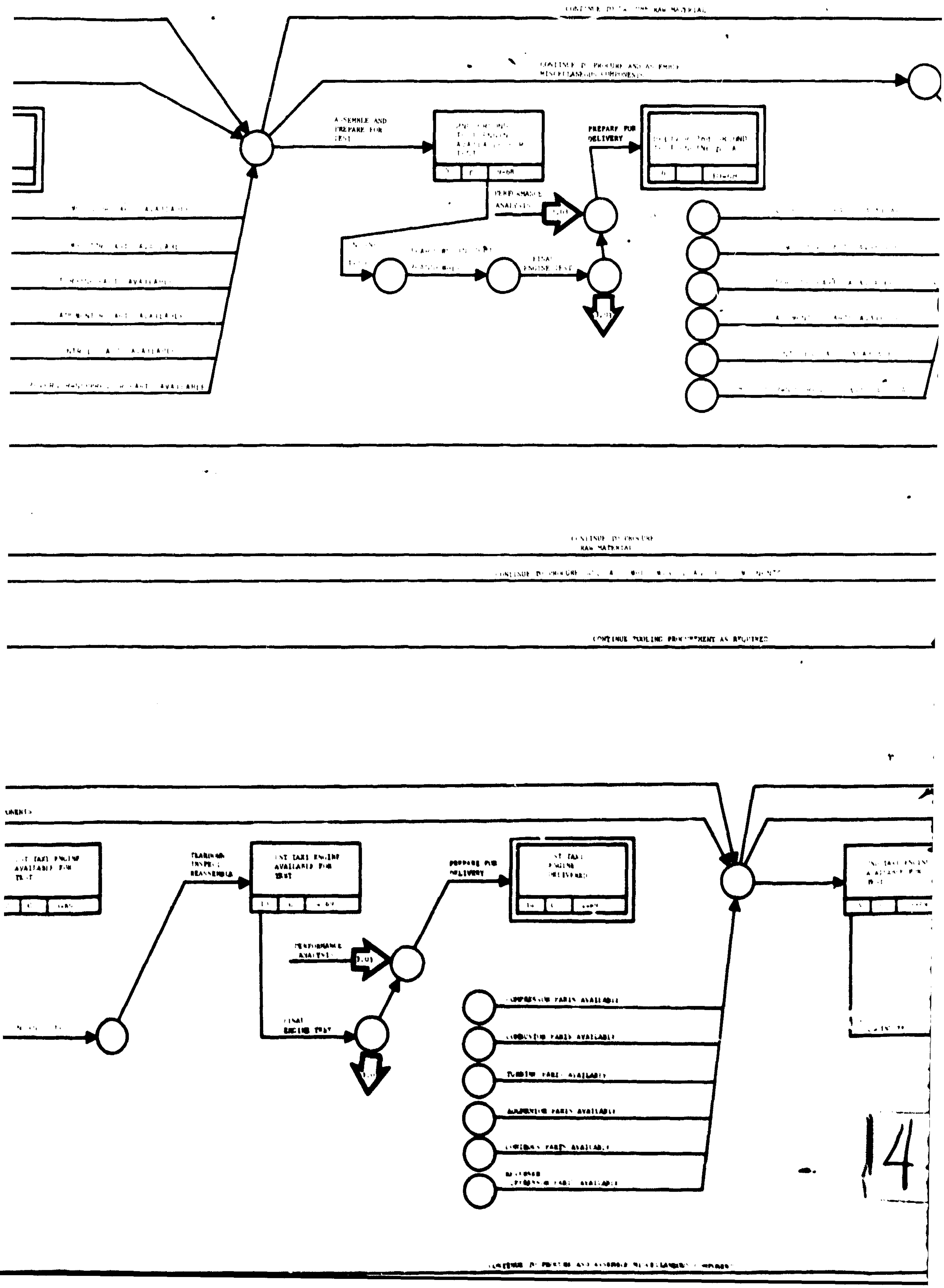

3.01 GROUND, TAXI
AND FLIGHT TEST ENGINES
PARTS LIST
TAXI
ENGINES
GO-AHEAD


PROCURE, FABRICATE AND ASSEMBLE
MISCELLANEOUS COMPONENTS -
1ST GROUND TEST ENGINE
PROCURE AND FABRICATE
MISCELLANEOUS COMPONENTS
PROCURE TOOLING
AS REQUIRED

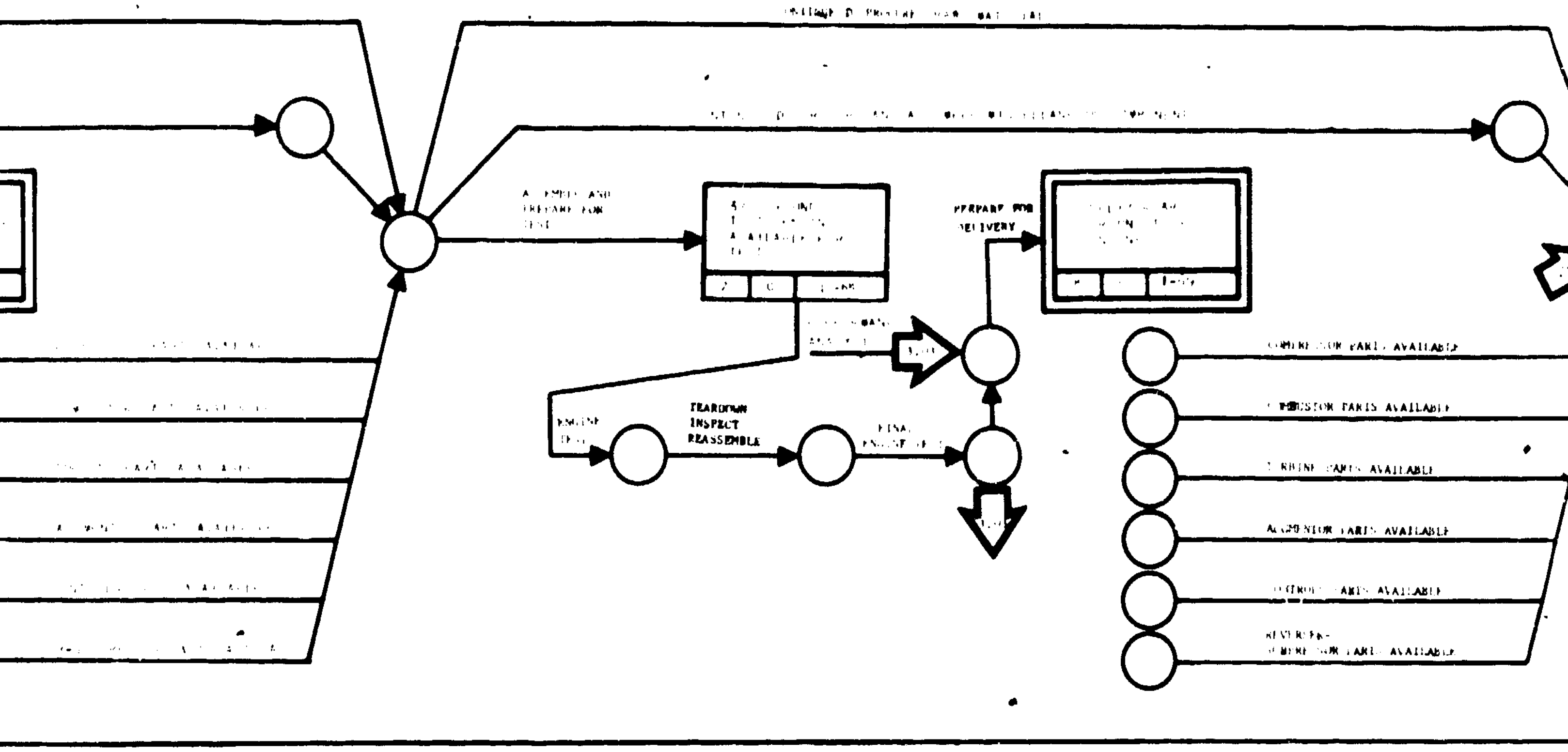
12

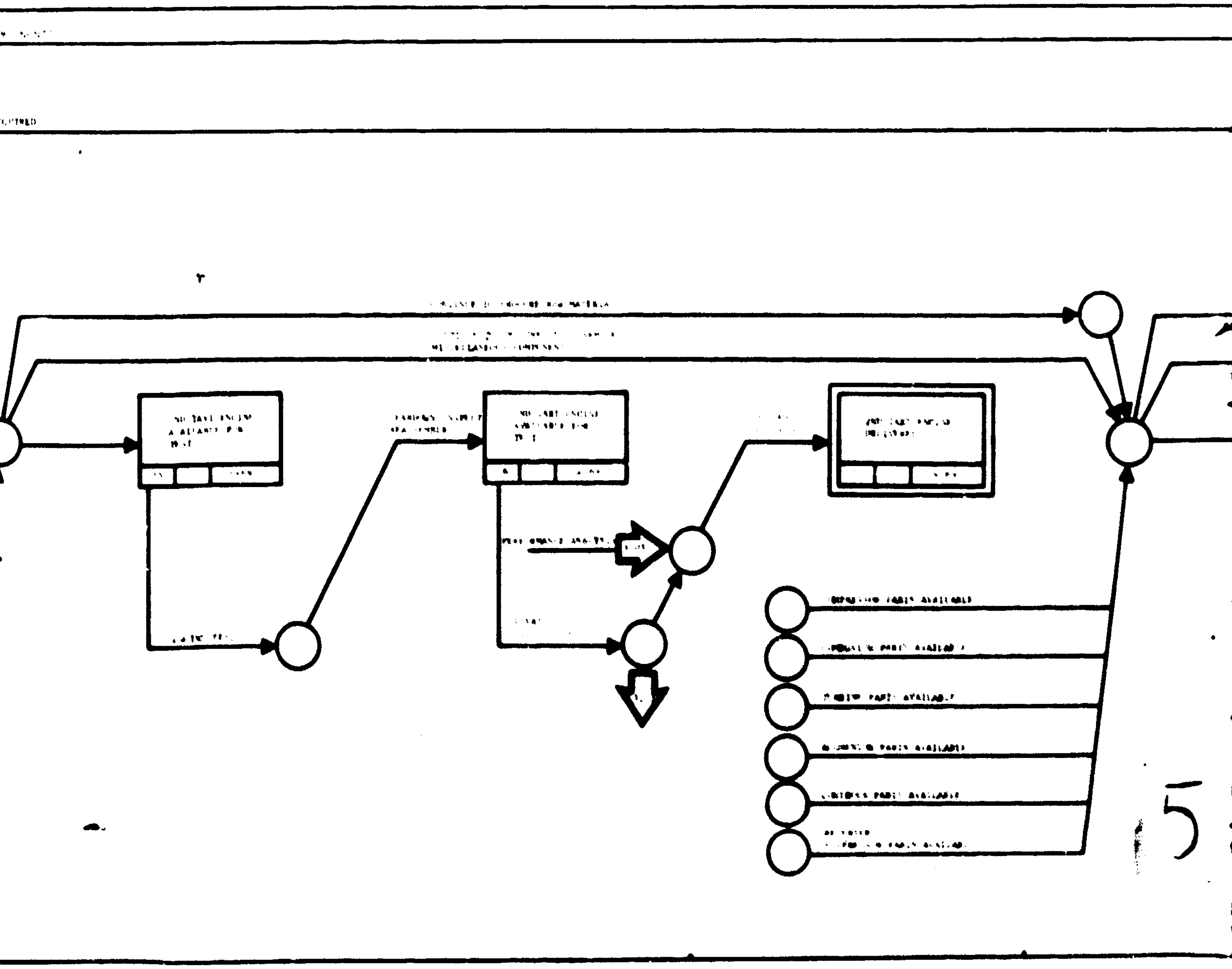

PERFORMANCE ANALYSIS
PREPARE FOR DELIVERY
FINAL
CONTINUE TO PROCURE RAW MATERIAL
CONTINUE TO PROCURE AND ASSEMBLE MISCELLANEOUS COMPONENTS
AVAILABLE FOR TEST

13


ASSEMBLE AND PREPARE FOR TEST
PREPARE FOR DELIVERY
PERFORMANCE ANALYSIS
FINAL ENGINE TEST
9-68
CONTINUE TO PROCURE RAW MATERIAL
CONTINUE TOOLING PROCUREMENT AS REQUIRED
PREPARE FOR DELIVERY
PERFORMANCE ANALYSIS
FINAL ENGINE TEST
COMPRESSOR PARTS AVAILABLE
COMBUSTOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
CONTROLS PARTS AVAILABLE

14


PREPARE FOR DELIVERY
TEARDOWN
INSPECT
REASSEMBLE
AUGMENTOR PARTS AVAILABLE



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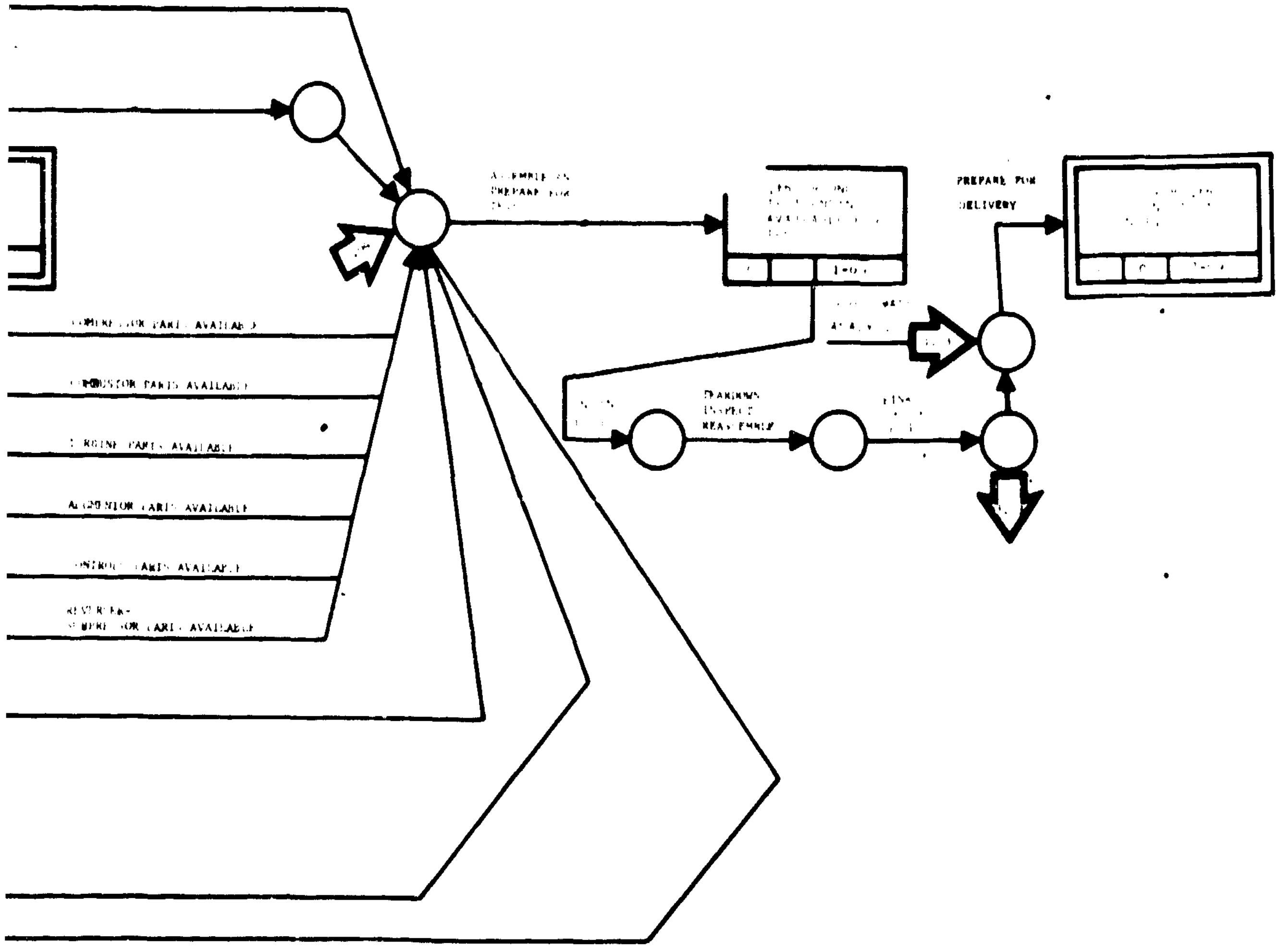
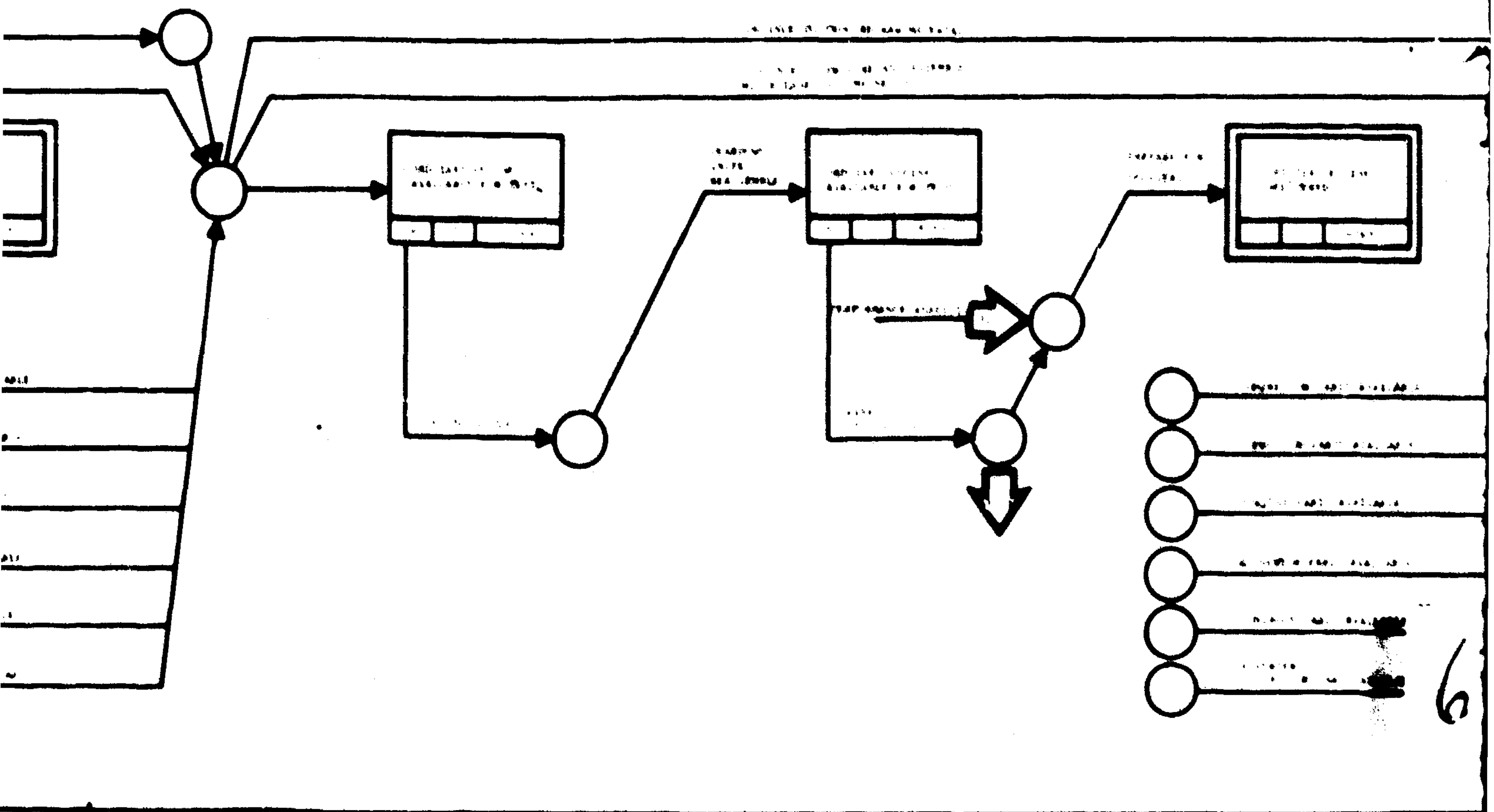
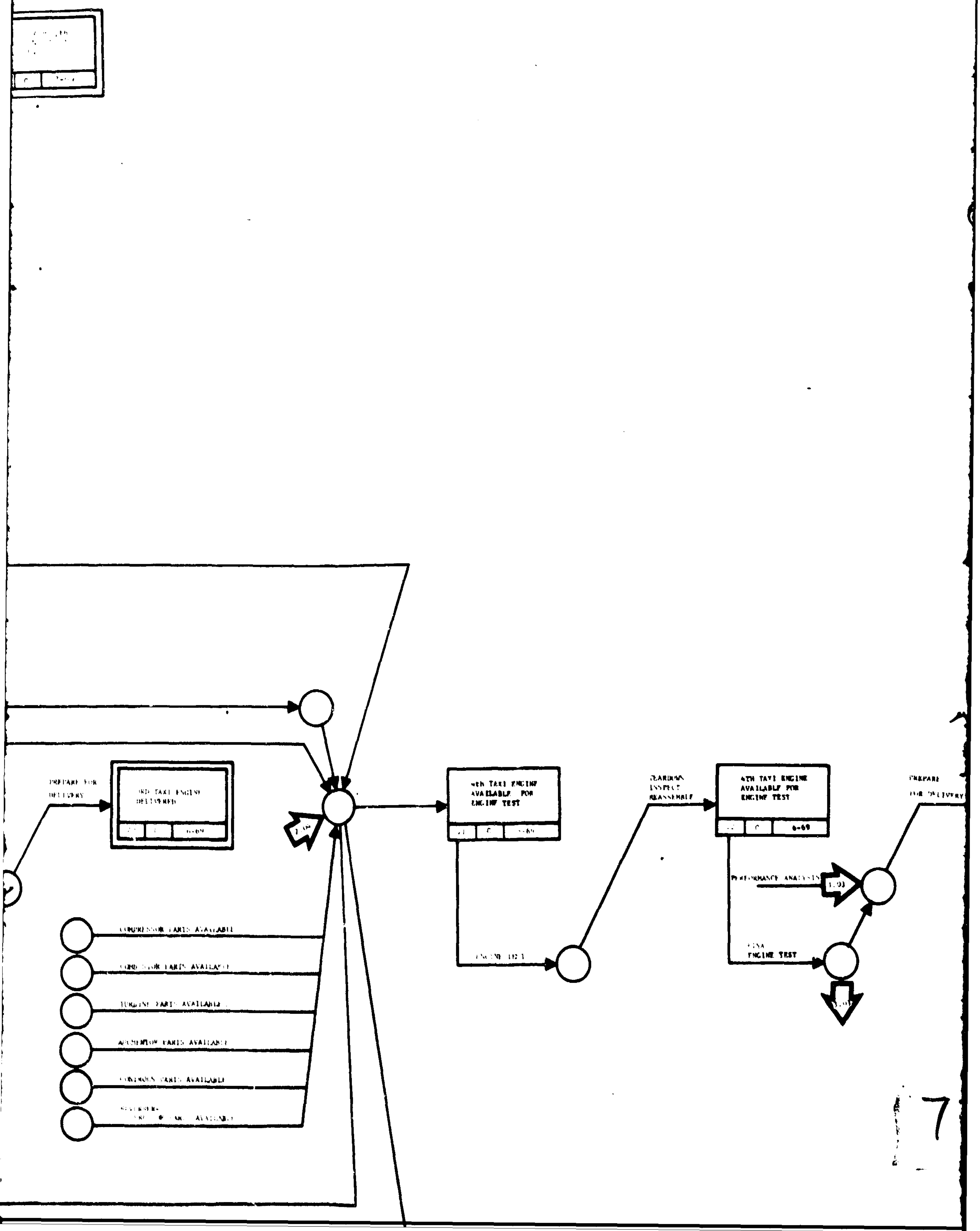
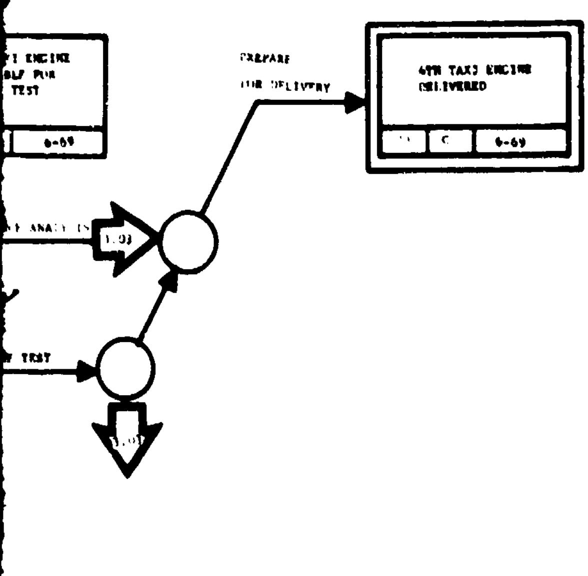




6

3.01 Ground, Taxi and Flight Test Engines





18

AS REQUIRED

TAXI [illegible]

[illegible]

[illegible] GROUND [illegible] ENGINE [illegible]

[illegible]

[illegible] GROUND TEST ENGINE AVAILABLE FOR TEST

[illegible]

DELIVER [illegible] GROUND TEST ENGINE [illegible]

[illegible]

2ND GROUND TEST ENGINE AVAILABLE FOR TEST

[illegible] The installation on the test [illegible] complete.

DELIVER 2ND GROUND TEST ENGINE [illegible]

[illegible]

3RD GROUND TEST ENGINE AVAILABLE FOR TEST

[illegible]

DELIVER 3RD GROUND TEST ENGINE

[illegible] The engine is shipped.

4TH GROUND TEST ENGINE AVAILABLE FOR TEST

[illegible] installation on [illegible] complete.

DELIVER 4TH GROUND TEST ENGINE

Deliver the 4th ground test engine [illegible] completed. The [illegible] shipped.

19

TAXI ENGINES [illegible]

[illegible]

1ST TAXI ENGINE AVAILABLE FOR TEST

[illegible]

1ST TAXI ENGINE AVAILABLE FOR TEST

[illegible] complete.

1ST TAXI ENGINE DELIVERED

Deliver [illegible] taxi engine after completing final [illegible] shipped.

2ND TAXI ENGINE AVAILABLE FOR TEST

The second taxi engine is ready for [illegible] testing. The installation on the [illegible] complete.

2ND TAXI ENGINE AVAILABLE FOR TEST

[illegible] taxi engine is ready for final testing. The installation on the test stand is complete.

2ND TAXI ENGINE DELIVERED

Deliver the 2nd taxi engine after completing final test [illegible] The engine is shipped.

3RD TAXI ENGINE AVAILABLE FOR TEST

The third taxi engine is ready for [illegible] testing. The installation on the test stand is complete.

3RD TAXI ENGINE AVAILABLE FOR TEST

The third taxi engine is ready for final testing. The installation on the test stand is complete.

3RD TAXI ENGINE DELIVERED

Deliver the 3rd taxi engine after completing final test [illegible] The engine is shipped.

4TH TAXI ENGINE AVAILABLE FOR TEST

The fourth taxi engine is ready for [illegible] testing. The installation on the stand is complete.

4TH TAXI ENGINE AVAILABLE FOR TEST

The fourth taxi engine is ready for final testing. The installation on the test stand is complete.

19

Event No. [illegible] | Description and Criteria | Event No. | Description and Criteria

4TH TAXI ENGINE DELIVERED
[illegible] after completion [illegible] shipped.

REFURBISH [illegible] TAXI ENGINE [illegible] GO-AHEAD
[illegible] to the prototype configuration [illegible] received from the airframe contractor.

1ST AND 2ND TAXI ENGINES RETURNED FOR REFURBISHMENT AND REDELIVERY
The 1st and 2nd taxi engines returned from the airframe contractor for refurbishment to the prototype configuration and redelivery to the airframe contractor. The engines are received from the airframe contractor.

3RD AND 4TH TAXI ENGINES RETURNED FOR REFURBISHMENT AND REDELIVERY
The 3rd and 4th taxi engines returned from the airframe contractor for refurbishment to the prototype configuration and redelivery to the airframe contractor. The engines are received from the airframe contractor.

PROTOTYPE ENGINES GO-AHEAD
Proceed with the procurement of raw material, tooling, and fabrication of parts for the prototype engines. Go-ahead received from FAA.

ENGINE [illegible]
Reference engine network [illegible] for description and criteria.

1ST PROTOTYPE ENGINE AVAILABLE FOR TEST
The first prototype engine is ready for [illegible] testing. The installation on the test stand is complete.

1ST PROTOTYPE ENGINE AVAILABLE FOR TEST
The first prototype engine is ready for final testing. The installation on the test stand is complete.

1ST PROTOTYPE ENGINE DELIVERED
Deliver the 1st prototype engine after completing final test runs. The engine is shipped.

2ND PROTOTYPE ENGINE AVAILABLE FOR TEST
The second prototype engine is ready for [illegible] testing. The installation on the test stand is complete.

2ND PROTOTYPE ENGINE AVAILABLE FOR TEST
The second prototype engine is ready for final testing. The installation on the test stand is complete.

2ND PROTOTYPE ENGINE DELIVERED
Deliver the 2nd prototype engine after completing final test runs. The engine is shipped.

3RD PROTOTYPE ENGINE AVAILABLE FOR TEST
The third prototype engine is ready for [illegible] testing. The installation on the test stand is complete.

3RD PROTOTYPE ENGINE AVAILABLE FOR TEST
The third prototype engine is ready for final testing. The installation on the test stand is complete.

3RD PROTOTYPE ENGINE DELIVERED
Deliver the 3rd prototype engine after completing final test runs. The engine is shipped.

4TH PROTOTYPE ENGINE AVAILABLE FOR TEST
The fourth prototype engine is ready for [illegible] testing. The installation on the test stand is complete.

4TH PROTOTYPE ENGINE AVAILABLE FOR TEST
The fourth prototype engine is ready for final testing. The installation on the test stand is complete.

4TH PROTOTYPE ENGINE DELIVERED
Deliver the 4th prototype engine after completing final test runs. The engine is shipped.

5TH PROTOTYPE ENGINE AVAILABLE FOR TEST
The fifth prototype engine is ready for [illegible] testing. The installation on the test stand is complete.

5TH PROTOTYPE ENGINE AVAILABLE FOR TEST
The fifth prototype engine is ready for final testing. The installation on the test stand is complete.

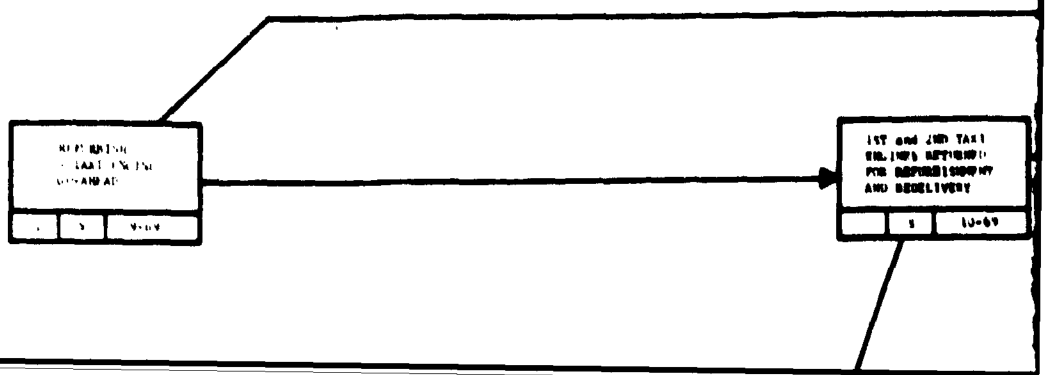
10

[illegible] DICTIONARY

[illegible] PROTOTYPE, TEST AND [illegible] ENGINE

Description and Criteria	Description and Criteria
[illegible] PROTOTYPE ENGINE DELIVERED [illegible] prototype [illegible] after completing [illegible]. The [illegible] shipped.	9TH PROTOTYPE ENGINE AVAILABLE FOR TEST The ninth prototype engine is ready for final tests [illegible] installation on the test stand is complete.
[illegible] PROTOTYPE ENGINE AVAILABLE FOR TEST The [illegible] prototype engine is ready for [illegible] testing. The installation on the test stand is complete.	9TH PROTOTYPE ENGINE DELIVERED Deliver the 9th prototype [illegible] after completing final tests. The [illegible] is shipped.
[illegible] PROTOTYPE ENGINE AVAILABLE FOR TEST The [illegible] prototype engine is ready for final tests. The installation on the test stand is complete.	10TH PROTOTYPE ENGINE AVAILABLE FOR TEST The tenth prototype engine is ready for [illegible] testing. The installation on the test stand is complete.
[illegible] PROTOTYPE ENGINE DELIVERED Deliver the [illegible] prototype [illegible] after completing [illegible] tests. The engine is shipped.	10TH PROTOTYPE ENGINE AVAILABLE FOR TEST The tenth prototype engine is ready for final tests. The installation on the test stand is complete.
[illegible] PROTOTYPE ENGINE AVAILABLE FOR TEST The [illegible] prototype engine is ready for [illegible] testing. The installation on the test stand is complete.	10TH PROTOTYPE ENGINE DELIVERED Deliver the 10th prototype engine after completing final test runs. The engine is shipped.
[illegible] PROTOTYPE ENGINE AVAILABLE FOR TEST [illegible] prototype [illegible] is ready for final tests. The installation on the test stand is complete.	11TH PROTOTYPE ENGINE AVAILABLE FOR TEST The eleventh prototype engine is ready for [illegible] testing. The installation on the test stand is complete.
[illegible] PROTOTYPE ENGINE DELIVERED Deliver the [illegible] prototype engine after completing final test runs. The engine is shipped.	11TH PROTOTYPE ENGINE AVAILABLE FOR TEST The eleventh prototype engine is ready for final tests. The installation on the test stand is complete.
[illegible] PROTOTYPE ENGINE AVAILABLE FOR TEST The [illegible] prototype engine is ready for [illegible] testing. The installation on the test stand is complete.	11TH PROTOTYPE ENGINE DELIVERED Deliver the 11th prototype engine after completing final test runs. The engine is shipped.
8TH PROTOTYPE ENGINE AVAILABLE FOR TEST The [illegible] prototype engine is ready for final tests. The installation on the test stand is complete.	12TH PROTOTYPE ENGINE AVAILABLE FOR TEST The twelfth prototype engine is ready for [illegible] testing. The installation on the test stand is complete.
8TH PROTOTYPE ENGINE DELIVERED Deliver the 8th prototype engine after completing final test runs. The engine is shipped.	12TH PROTOTYPE ENGINE AVAILABLE FOR TEST The twelfth prototype engine is ready for final tests. The installation on the test stand is complete.
9TH PROTOTYPE ENGINE AVAILABLE FOR TEST The ninth prototype engine is ready for [illegible] testing. The installation on the test stand is complete.	12TH PROTOTYPE ENGINE DELIVERED Deliver the 12th prototype engine after completing final test runs. The engine is shipped.

11



Event Number	Description and Criteria	Event Number	Description and Criteria
	1ST REFURBISHED TAXI ENGINE AVAILABLE FOR TEST Refurbishment of the 1st taxi engine to the prototype configuration is complete and the engine is available for test. Installation on the test stand is complete.		**ENGINE CERTIFICATION** [illegible]
	DELIVER 1ST REFURBISHED TAXI ENGINE Deliver the 1st taxi engine refurbished to the prototype configuration after completing final test runs. This will be the [illegible] prototype engine. The engine is shipped.		
	2ND REFURBISHED TAXI ENGINE AVAILABLE FOR TEST Refurbishment of the 2nd taxi engine to the prototype configuration is complete and the engine is available for test. Installation on the test stand is complete.		
	DELIVER 2ND REFURBISHED TAXI ENGINE Deliver the 2nd taxi engine refurbished to the prototype configuration after completing final test runs. This will be the [illegible] prototype engine. The engine is shipped.		
	3RD REFURBISHED TAXI ENGINE AVAILABLE FOR TEST Refurbishment of the 3rd taxi engine to the prototype configuration is complete and the engine is available for test. Installation on the test stand is complete.		
	DELIVER 3RD REFURBISHED TAXI ENGINE Deliver the 3rd taxi engine refurbished to the prototype configuration after completing final test runs. This will be the [illegible] prototype engine. The engine is shipped.		
	4TH REFURBISHED TAXI ENGINE AVAILABLE FOR TEST Refurbishment of the 4th taxi engine to the prototype configuration is complete and the engine is available for test. Installation on the test stand is complete.		
	DELIVER 4TH REFURBISHED TAXI ENGINE Deliver the 4th taxi engine refurbished to the prototype configuration after completing final test runs. This will be the [illegible] prototype engine. The engine is shipped.		
	COMPLETE SUSTAINING ENGINEERING FOR 140-HOUR FLIGHT TEST End of Phase III. Completion of 140-hour flight test program.		

12

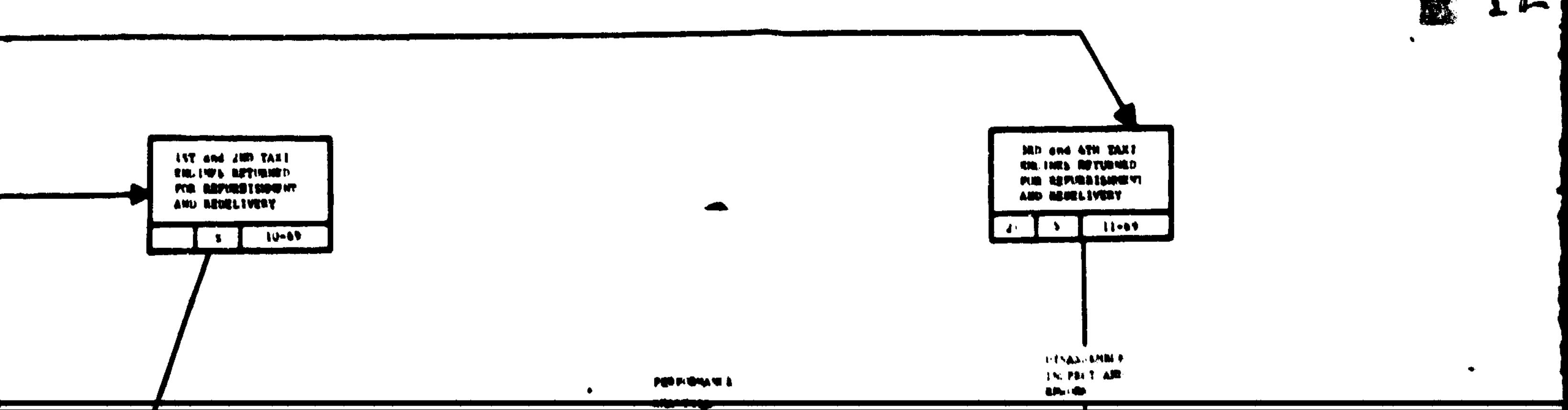
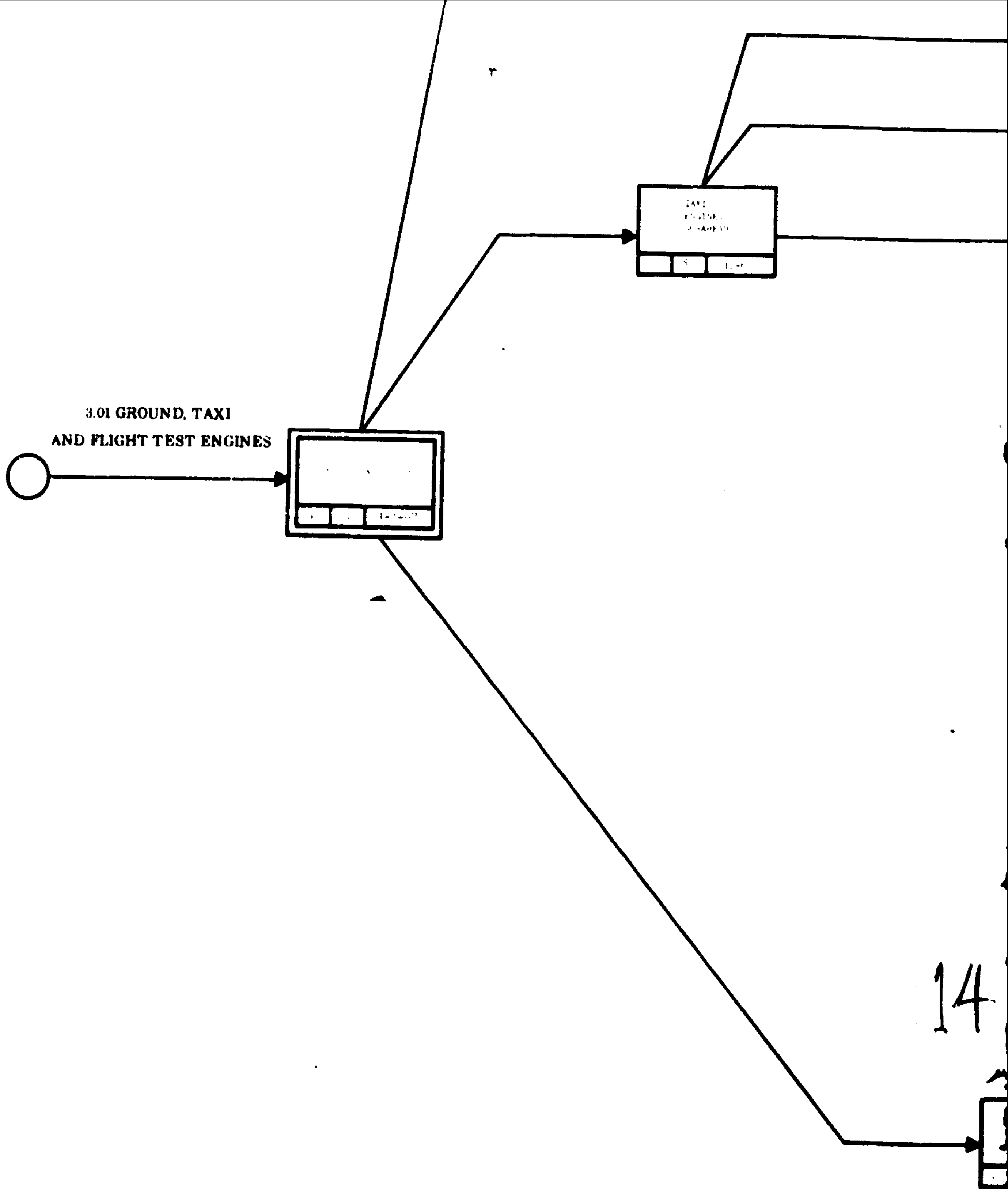


Figure 2.

13



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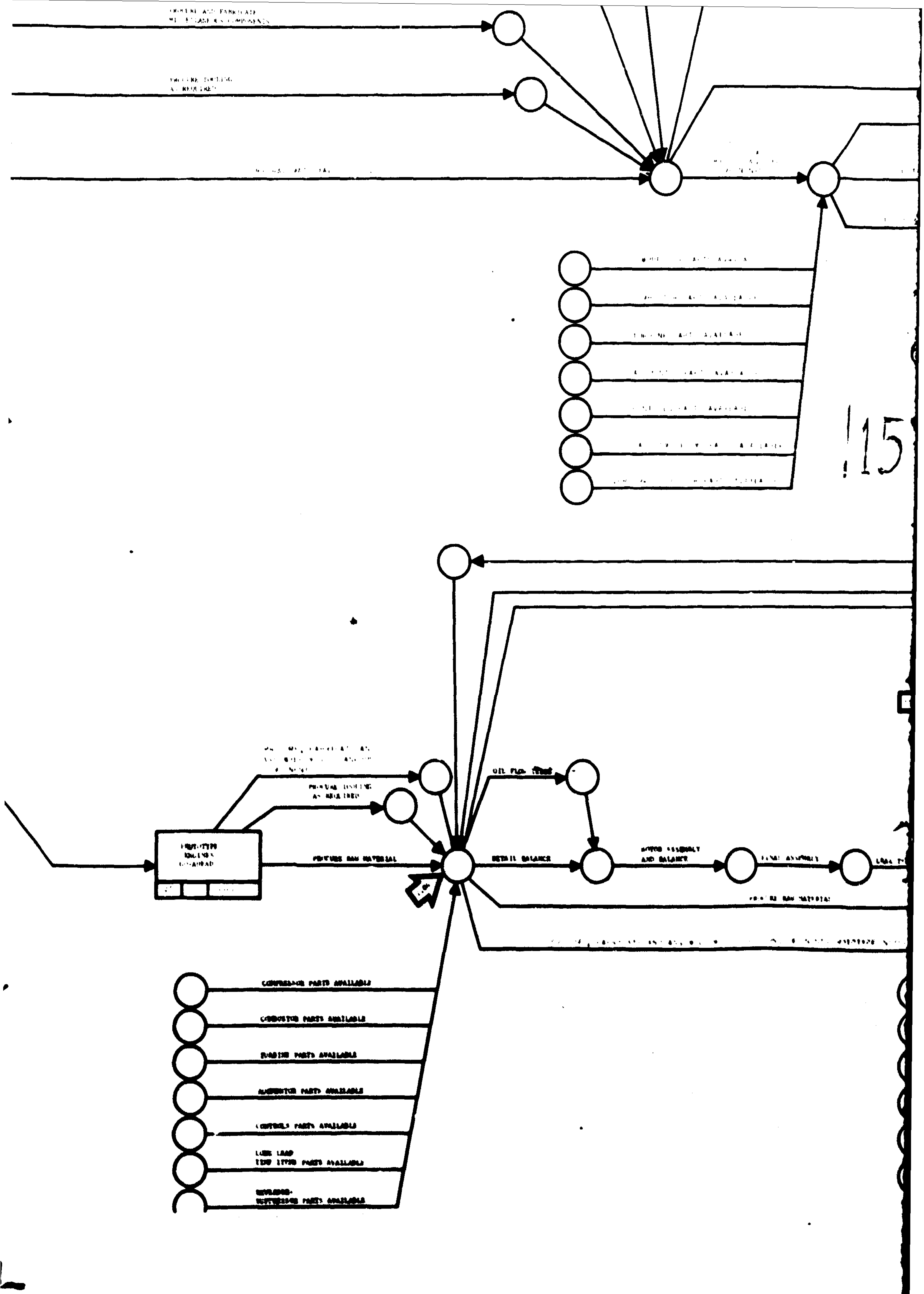
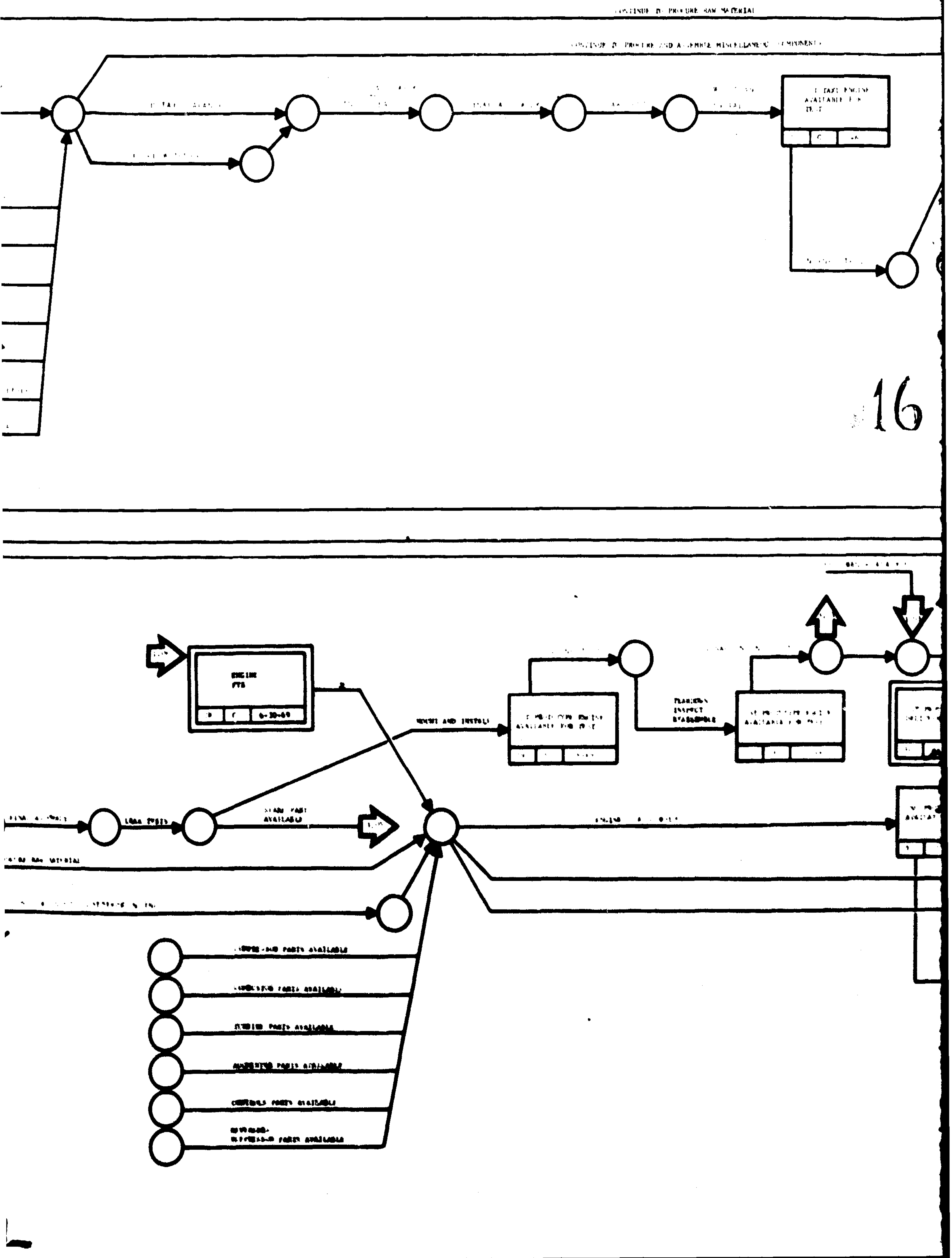
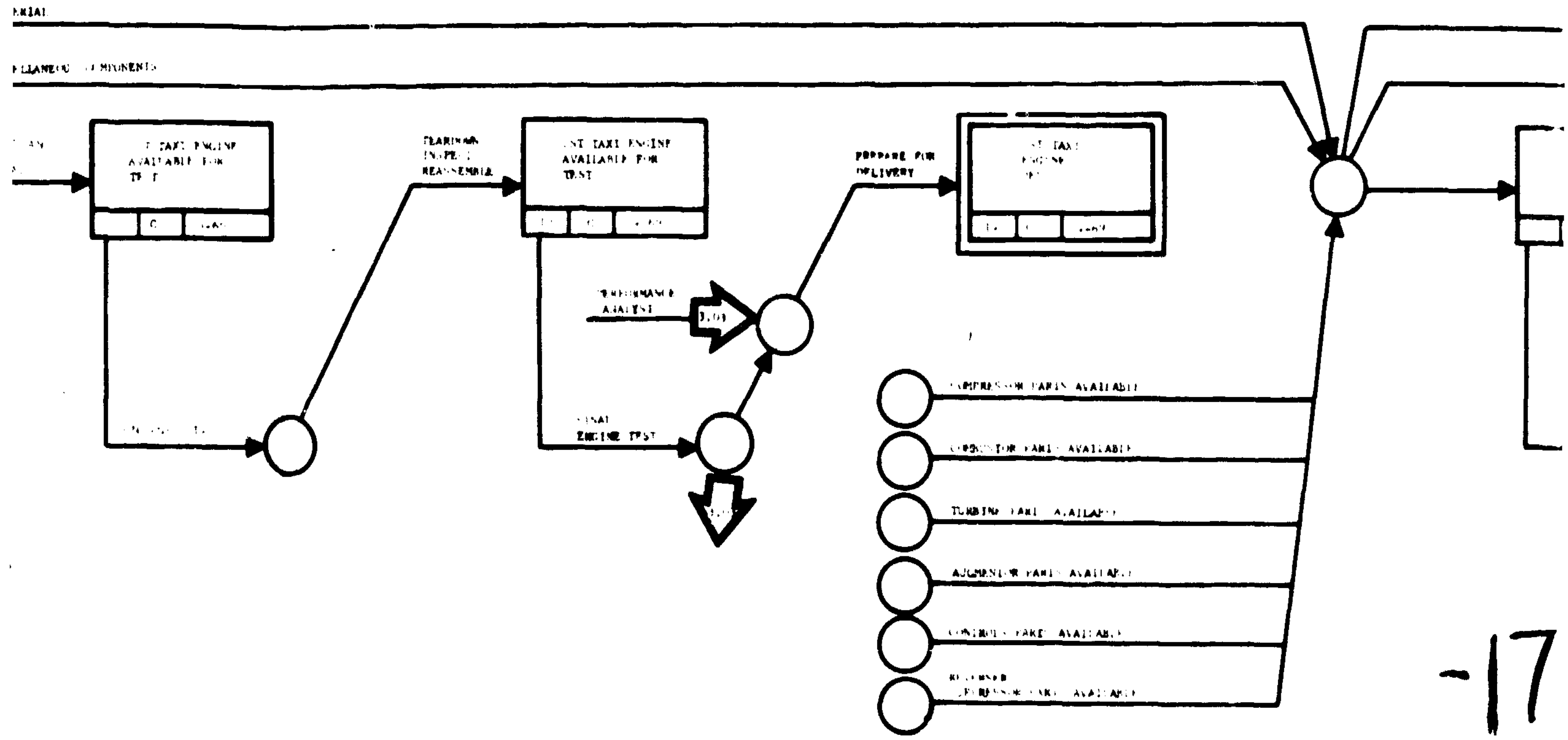


PROCURE TOOLING AS REQUIRED
15
PROCURE RAW MATERIAL
DETAIL BALANCE
ROTOR ASSEMBLY AND BALANCE
FINAL ASSEMBLY
COMPRESSOR PARTS AVAILABLE
COMBUSTOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
AUGMENTOR PARTS AVAILABLE
CONTROLS PARTS AVAILABLE

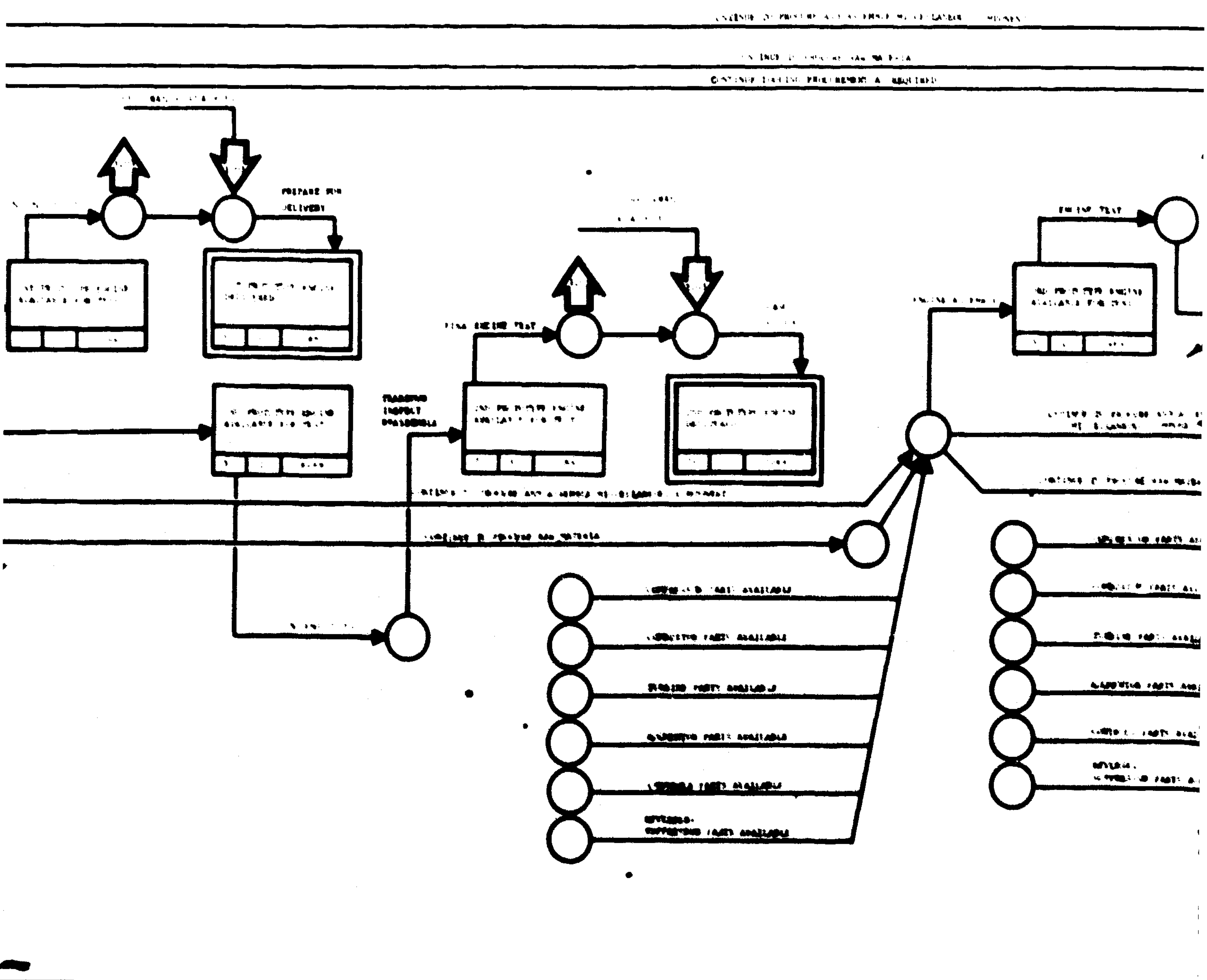


CONTINUE TO PROCURE RAW MATERIAL
ENGINE
6-30-69
MOUNT AND INSTALL
TEARDOWN
INSPECT
REASSEMBLE
START PART
AVAILABLE
CONTROLS PARTS AVAILABLE

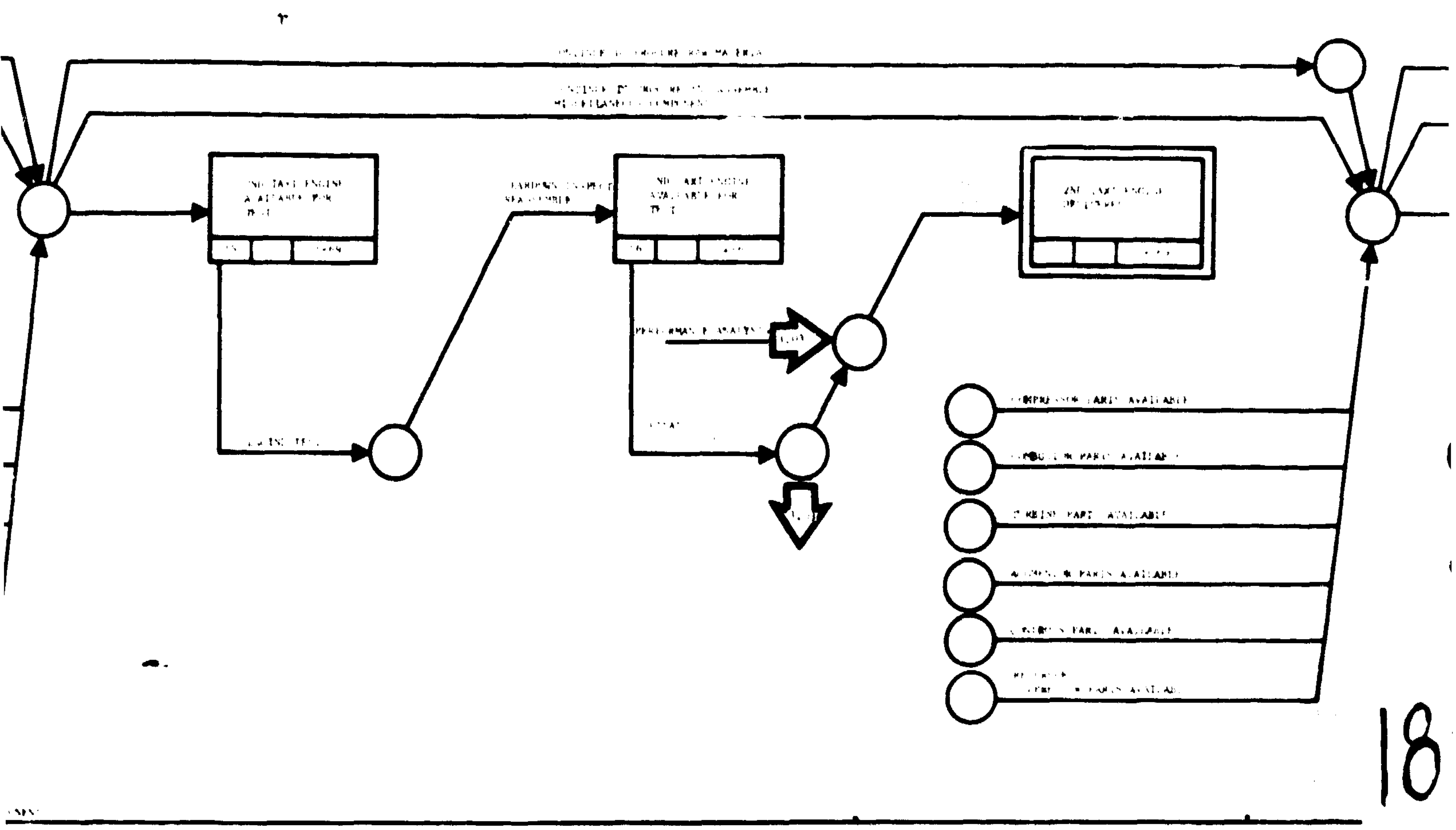
16



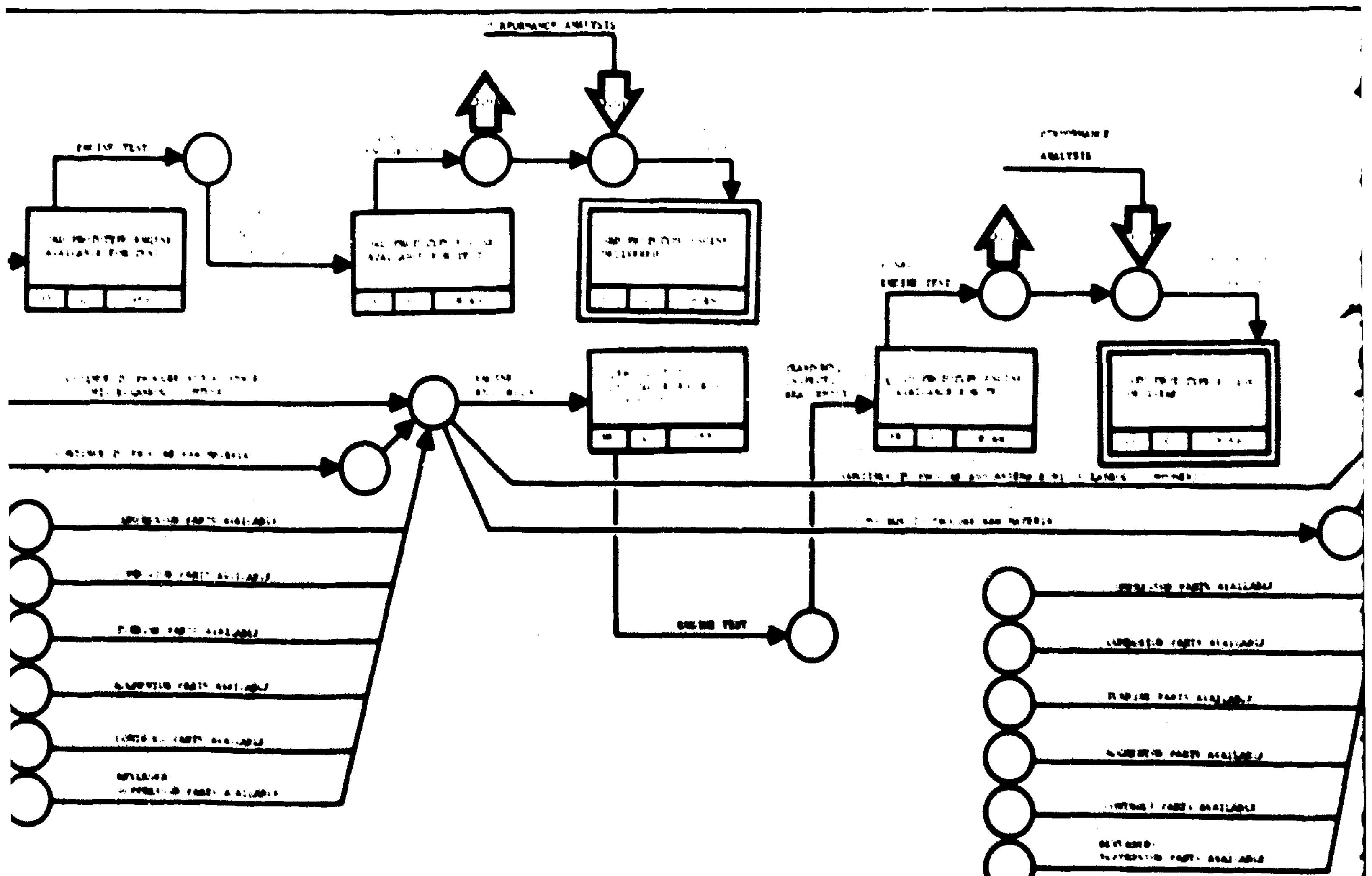
PREPARE FOR DELIVERY
FINAL ENGINE TEST
TURBINE PARTS AVAILABLE
-17

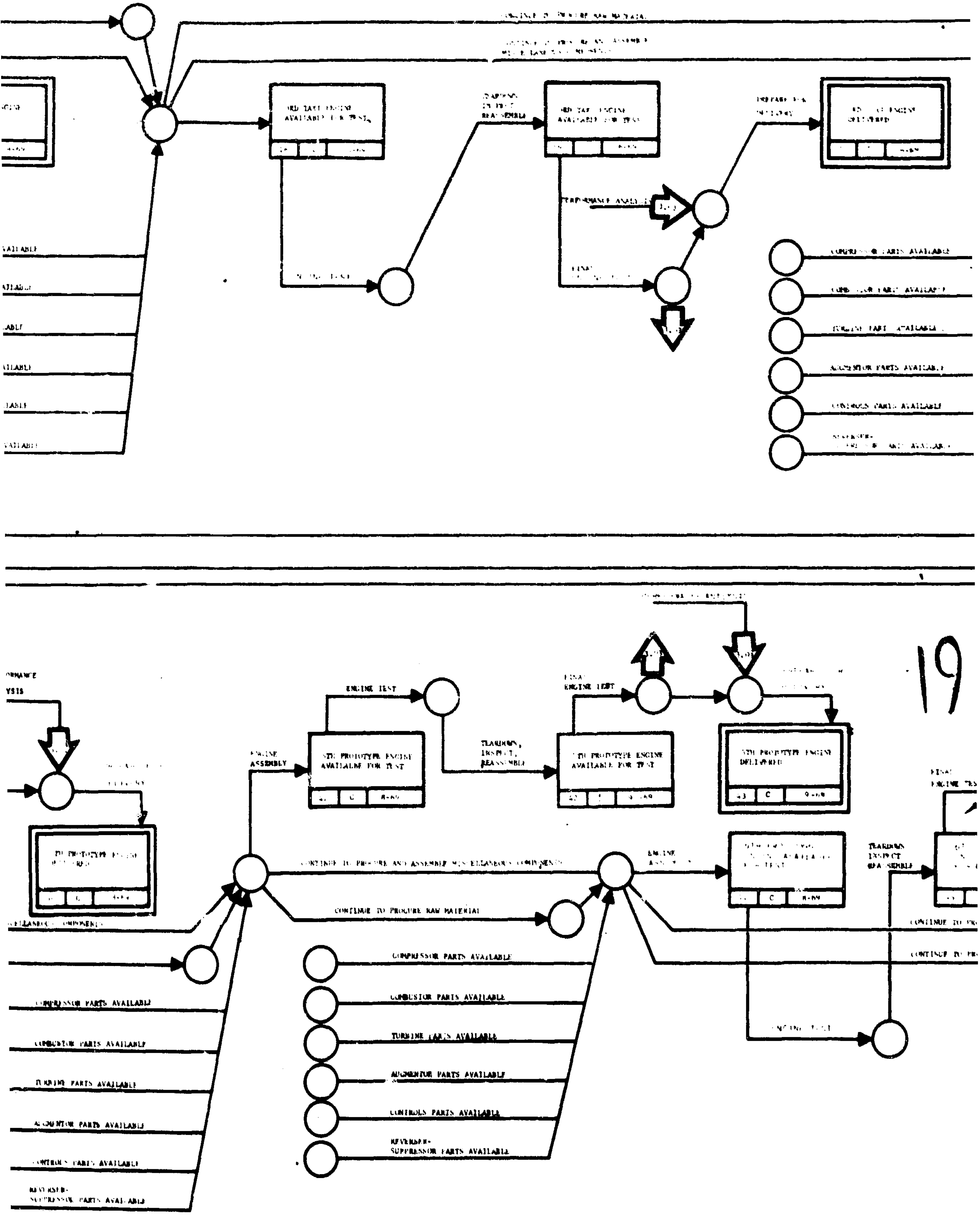


PREPARE FOR DELIVERY
ENGINE TEST

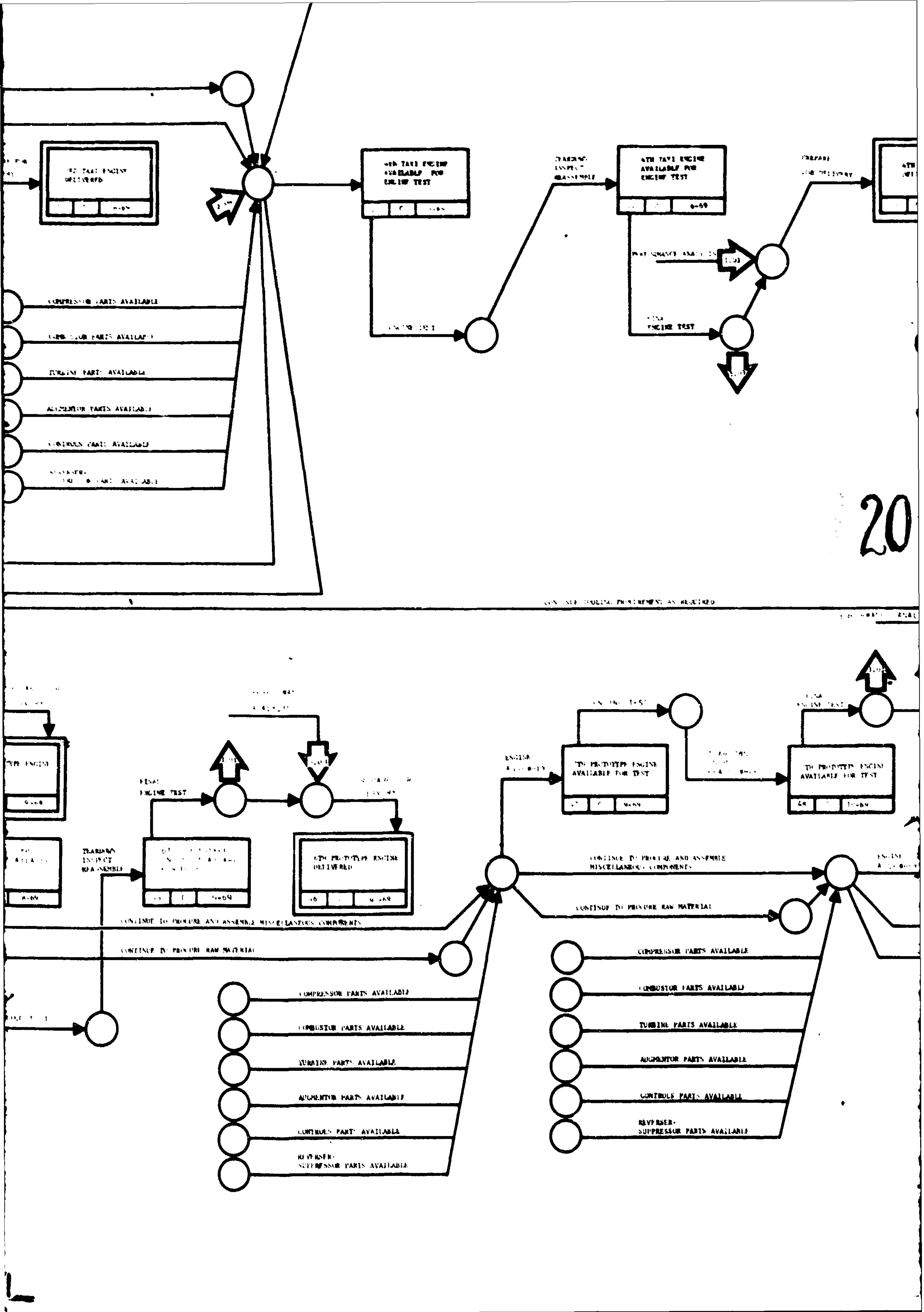

PERFORMANCE ANALYSIS

18

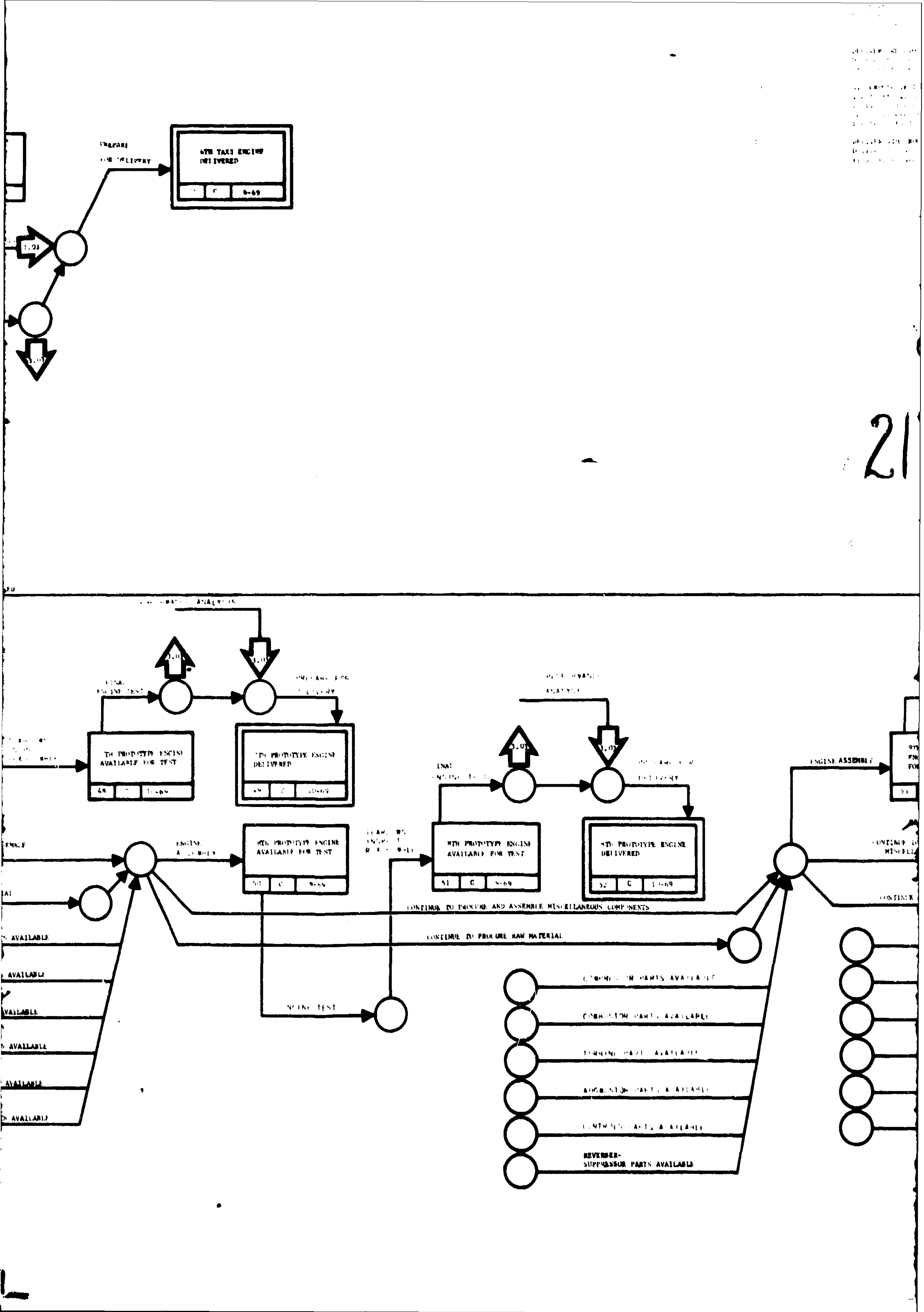

PERFORMANCE ANALYSIS
ENGINE TEST
ANALYSIS



PERFORMANCE ANALYSIS
COMPRESSOR PARTS AVAILABLE
AUGMENTOR PARTS AVAILABLE
ENGINE TEST
ENGINE ASSEMBLY
5TH PROTOTYPE ENGINE AVAILABLE FOR TEST
TEARDOWN, INSPECT, REASSEMBLE
FINAL ENGINE TEST
5TH PROTOTYPE ENGINE DELIVERED
CONTINUE TO PROCURE AND ASSEMBLE MISCELLANEOUS COMPONENTS
CONTINUE TO PROCURE RAW MATERIAL
COMPRESSOR PARTS AVAILABLE
COMBUSTOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
AUGMENTOR PARTS AVAILABLE
CONTROLS PARTS AVAILABLE
REVERSER-SUPPRESSOR PARTS AVAILABLE
19

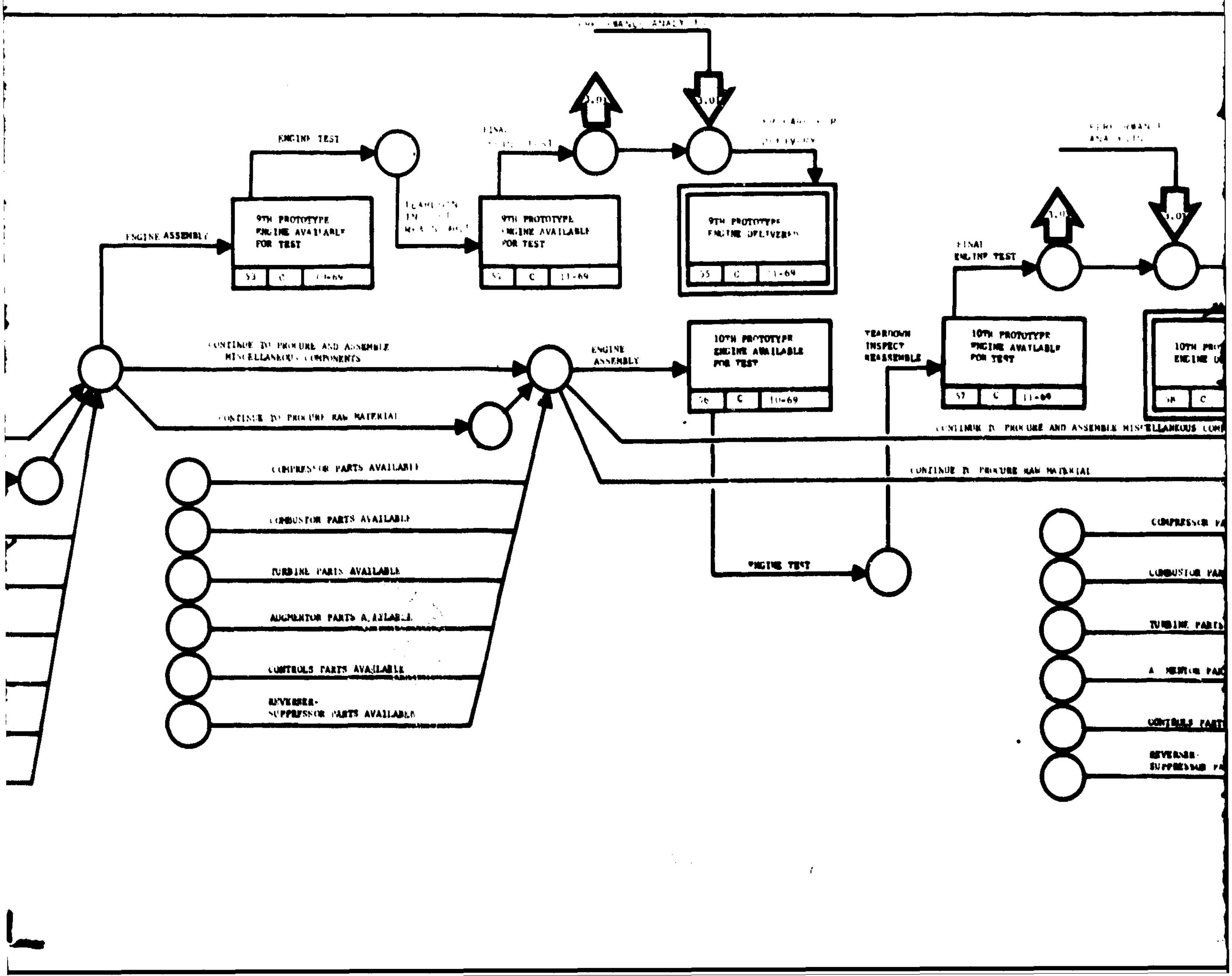


4TH TAXI ENGINE AVAILABLE FOR ENGINE TEST
TEARDOWN INSPECT REASSEMBLE
6TH TAXI ENGINE AVAILABLE FOR ENGINE TEST
6-69
PREPARE FOR DELIVERY
FINAL ENGINE TEST
COMPRESSOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
AUGMENTOR PARTS AVAILABLE
CONTROLS PARTS AVAILABLE
20
CONTINUE TOOLING PROCUREMENT AS REQUIRED
FINAL ENGINE TEST
9-69
TEARDOWN INSPECT REASSEMBLE
6TH PROTOTYPE ENGINE DELIVERED
ENGINE ASSEMBLY
7TH PROTOTYPE ENGINE AVAILABLE FOR TEST
7TH PROTOTYPE ENGINE AVAILABLE FOR TEST
10-69
CONTINUE TO PROCURE AND ASSEMBLE MISCELLANEOUS COMPONENTS
CONTINUE TO PROCURE RAW MATERIAL
CONTINUE TO PROCURE AND ASSEMBLE MISCELLANEOUS COMPONENTS
CONTINUE TO PROCURE RAW MATERIAL
COMPRESSOR PARTS AVAILABLE
COMBUSTOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
AUGMENTOR PARTS AVAILABLE
CONTROLS PARTS AVAILABLE
REVERSER-
SUPPRESSOR PARTS AVAILABLE



6TH TAXI ENGINE DELIVERED
9-69
ENGINE ASSEMBLY
8TH PROTOTYPE ENGINE AVAILABLE FOR TEST
50
C
9-69
8TH PROTOTYPE ENGINE AVAILABLE FOR TEST
51
C
9-69
8TH PROTOTYPE ENGINE DELIVERED
52
C
ENGINE ASSEMBLY
CONTINUE TO PROCURE AND ASSEMBLE MISCELLANEOUS COMPONENTS
CONTINUE TO PROCURE RAW MATERIAL
ENGINE TEST
REVERSER-
SUPPRESSOR PARTS AVAILABLE

22



ENGINE TEST
ENGINE ASSEMBLY
9TH PROTOTYPE ENGINE AVAILABLE FOR TEST
53 C 11-69
FINAL ENGINE TEST
9TH PROTOTYPE ENGINE AVAILABLE FOR TEST
9TH PROTOTYPE ENGINE DELIVERED
55 C 11-69
CONTINUE TO PROCURE AND ASSEMBLE MISCELLANEOUS COMPONENTS
CONTINUE TO PROCURE RAW MATERIAL
ENGINE ASSEMBLY
10TH PROTOTYPE ENGINE AVAILABLE FOR TEST
56 C 11-69
TEARDOWN INSPECT REASSEMBLE
10TH PROTOTYPE ENGINE AVAILABLE FOR TEST
57 C 11-69
FINAL ENGINE TEST
COMPRESSOR PARTS AVAILABLE
COMBUSTOR PARTS AVAILABLE
TURBINE PARTS AVAILABLE
AUGMENTOR PARTS AVAILABLE
CONTROLS PARTS AVAILABLE
REVERSER-SUPPRESSOR PARTS AVAILABLE
ENGINE TEST
CONTINUE TO PROCURE AND ASSEMBLE MISCELLANEOUS COMPONENTS
CONTINUE TO PROCURE RAW MATERIAL

[illegible]

[illegible] PROTOTYPE ENGINE AVAILABLE FOR TEST
The first prototype engine is ready for [illegible] testing. The installation on the test stand is complete.

1ST PROTOTYPE ENGINE AVAILABLE FOR TEST
The first prototype engine is ready for final testing. The installation on the test stand is complete.

1ST PROTOTYPE ENGINE DELIVERED
Deliver the 1st prototype engine after completion of final test runs. The engine is shipped.

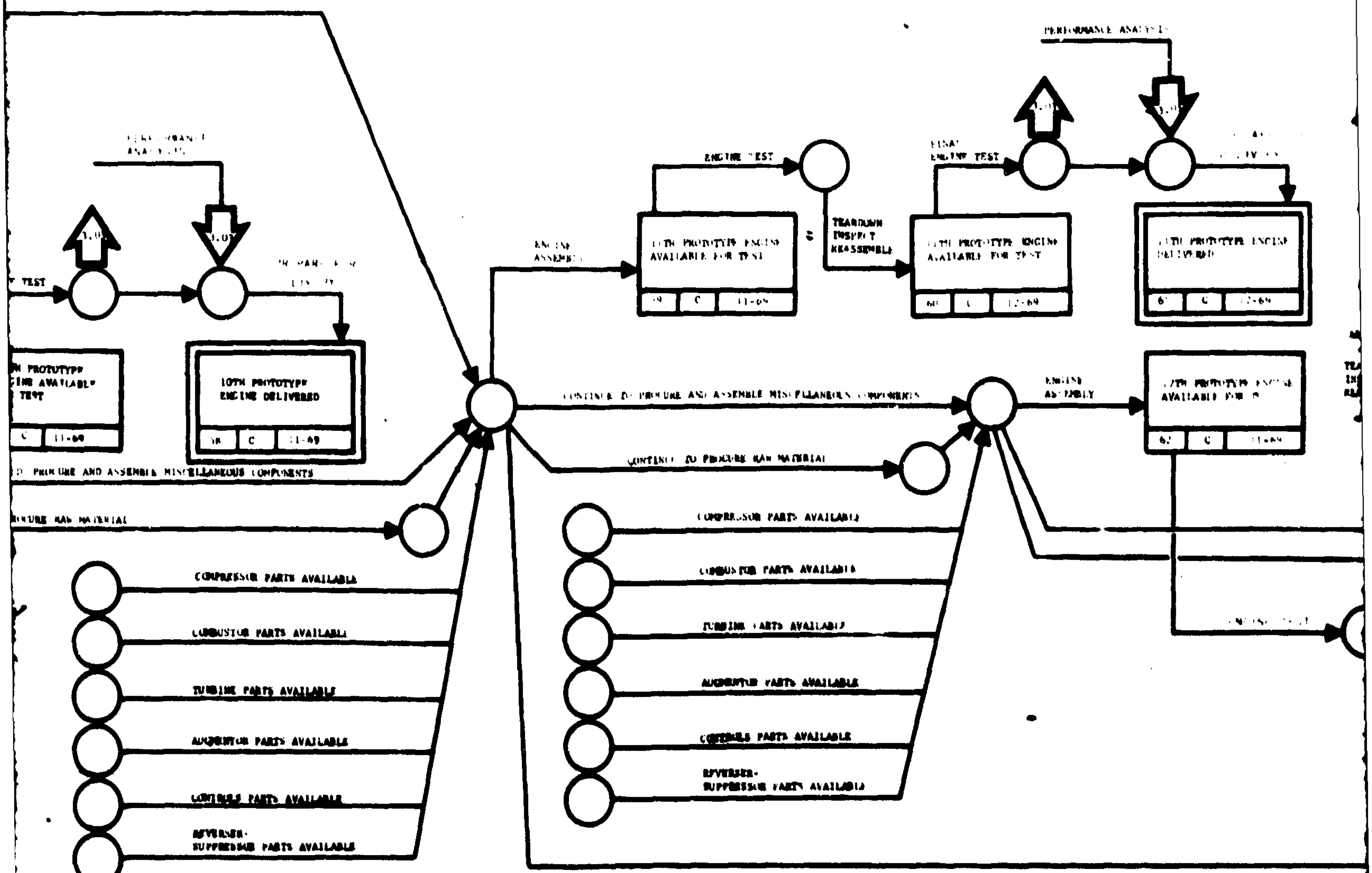
[illegible] PROTOTYPE ENGINE AVAILABLE FOR TEST
[illegible]

[illegible]TH PROTOTYPE ENGINE DELIVERED
Deliver the [illegible] prototype engine after completion of final test runs. The engine is shipped.

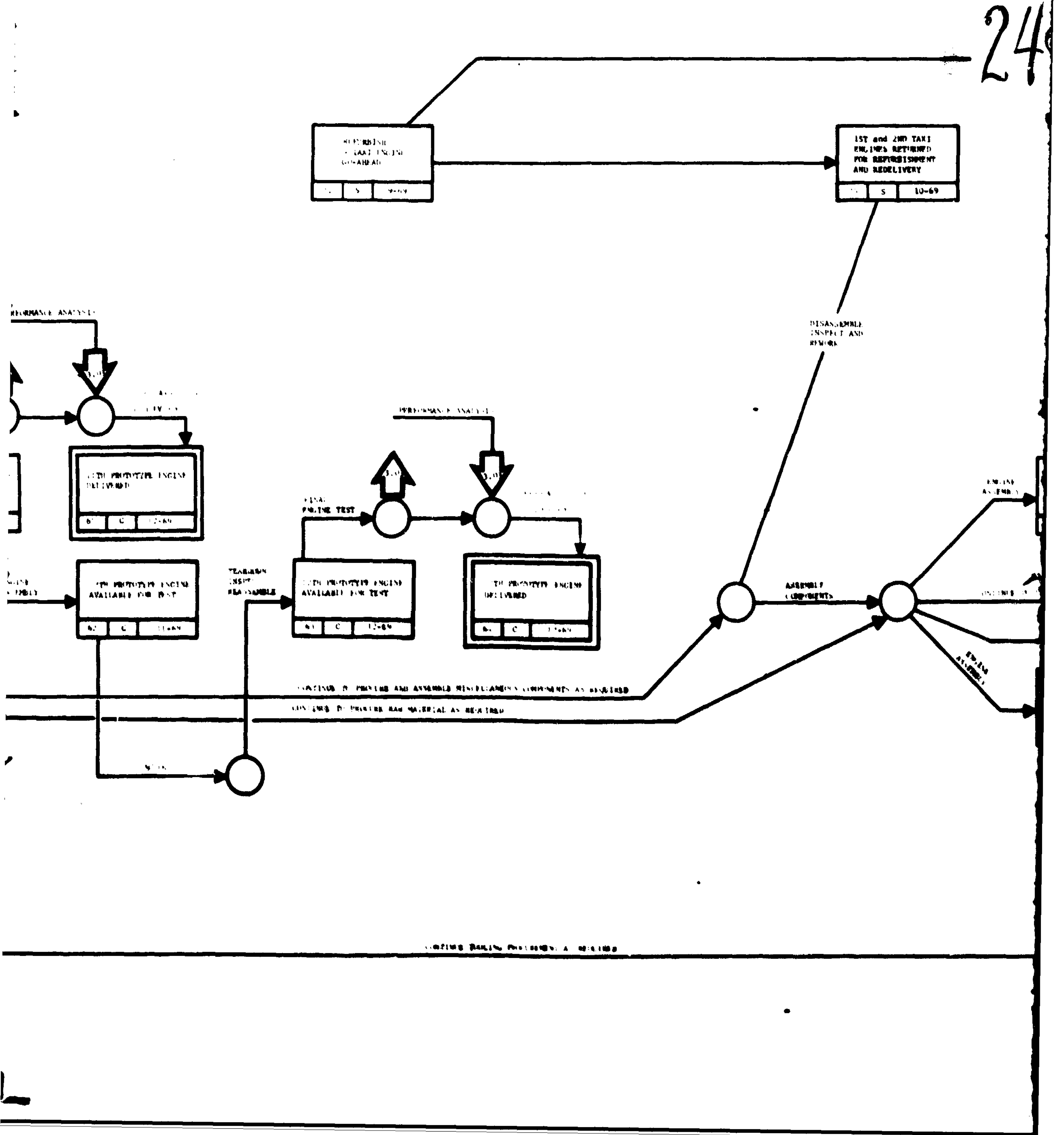
[illegible]TH PROTOTYPE ENGINE AVAILABLE FOR TEST
The fifth prototype engine is ready for [illegible] testing. The installation on the test stand is complete.

[illegible]TH PROTOTYPE ENGINE AVAILABLE FOR TEST
The fifth prototype engine is ready for final testing. The installation on the test stand is complete.

23



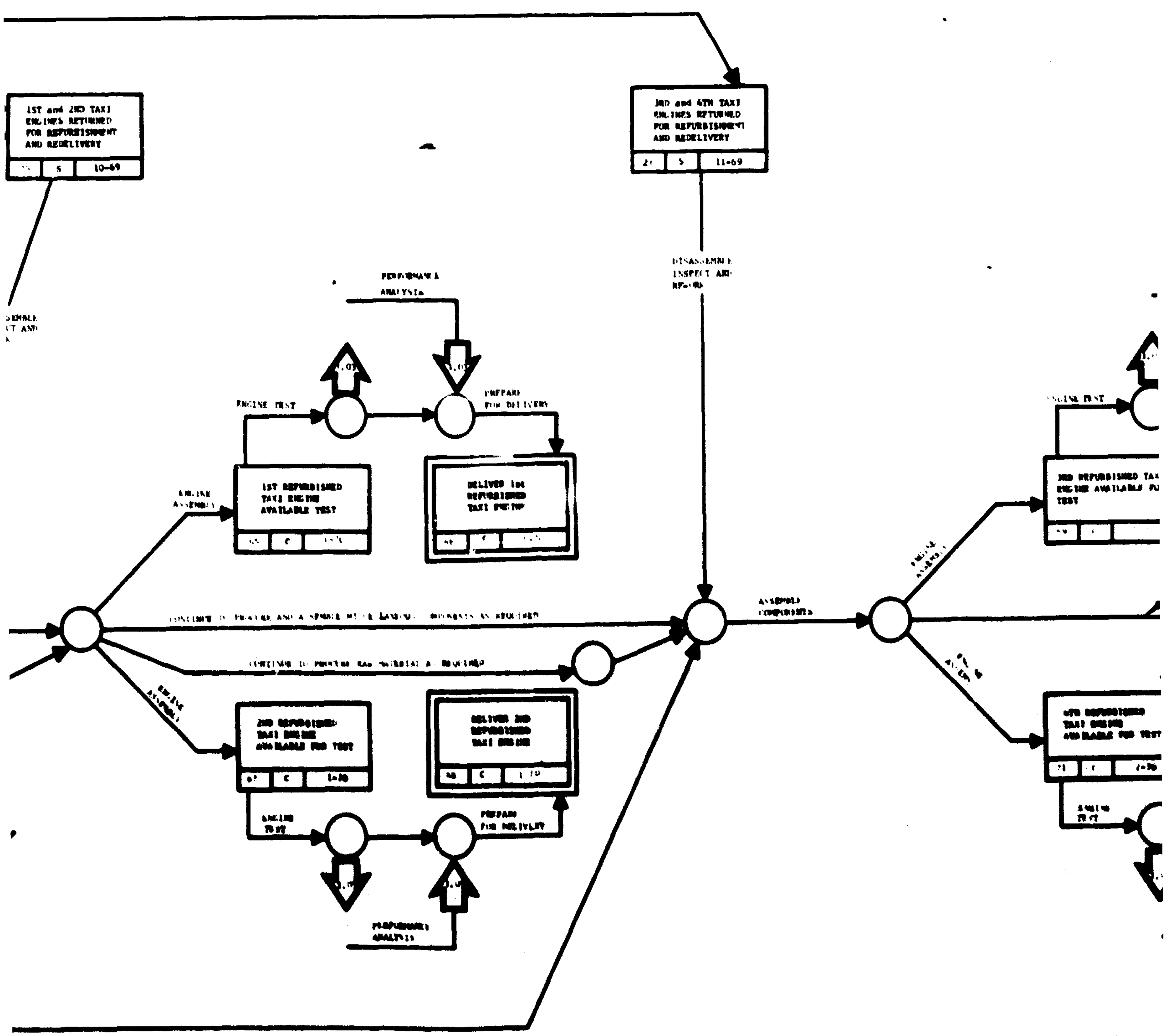
12TH PROTOTYPE ENGINE DELIVERED

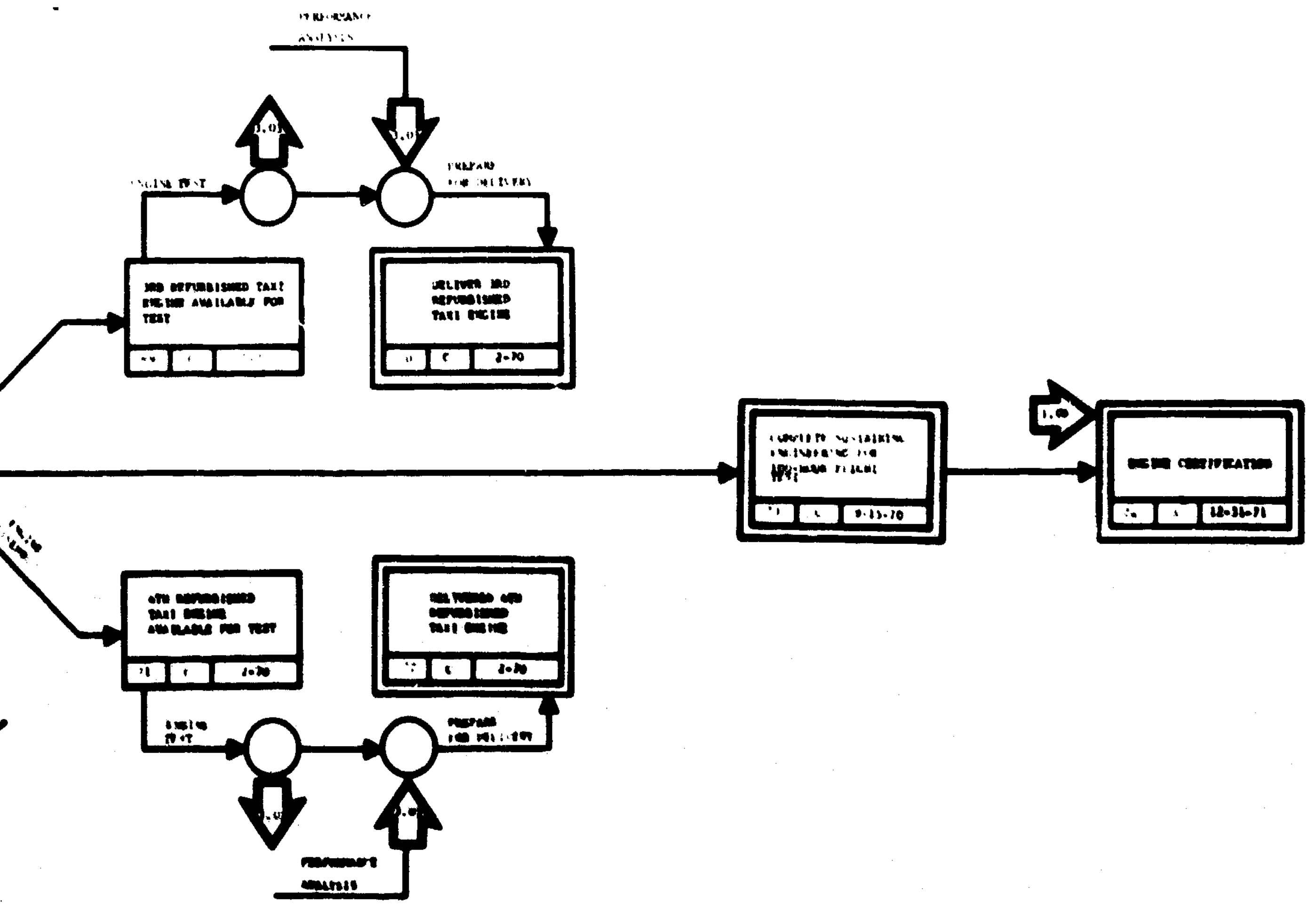


4TH REFURBISHED TAXI ENGINE AVAILABLE FOR TEST
Refurbishment of the 4th taxi engine to the prototype configuration is complete and the engine is available for test. Installation on the test stand is complete.

DELIVER 4TH REFURBISHED TAXI ENGINE
Deliver the 4th taxi engine refurbished to the prototype configuration after completing final test runs. This will be the 16th prototype engine. The engine is shipped.

COMPLETE SUSTAINING ENGINEERING FOR 100-HOUR FLIGHT TEST
End of Phase III. Completion of 100 hour flight test program.





26

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3.02 TOOLING

Special tools will be designed, procured, inspected and assembled in quantities to provide the capacity to meet the schedules of the JTF17 prototype and product support programs, described in detail in the Manufacturing Program, Volume V, Report G. As in Phase III development, the selection of the degree of tooling will be based on the maximum value in trade-off between labor costs and tooling costs.

The majority of in-house and subcontractor development tooling (70-80%) will be directly usable in the prototype and product support programs. This can be done since the development tooling will be gradually updated and modernized as design changes occur during the development phase. Maximum versatility will have been designed into the initial development tooling to handle the overlapping prototype, product support and continued development needs. This policy will apply to the new tooling necessary to meet prototype schedules.

Planning, as was performed during the development phase, will continue during the prototype program. All major assemblies and subassemblies will be analyzed during the layout stage. The experience gained during development will be invaluable not only to Planning and Manufacturing, but also as input to Design relative to producibility, which will stabilize the engine design and expedite final planning and tool design.

Process Engineering, which is responsible for specifying the special tools required by the manufacturing areas, is organized into groups that parallel the manufacturing areas of operation. This permits specialized effort and maximum application of experience. Special tools will be planned, designed, and ordered in the quantity to provide capacity to meet manufacturing schedules. Tool design and tool build will be scheduled to ensure that tooling will be available as required.

Most of the subcontractors utilized during the development phase will continue manufacture during the prototype and overhaul phase. In some cases additional or "hard" tooling must be added to supplement existing tooling for manufacture of JTF17 prototype and overhaul quantity of parts.

The major milestones, network chart and event dictionary for the prototype tooling program are shown in figures 3 and 4, respectively.

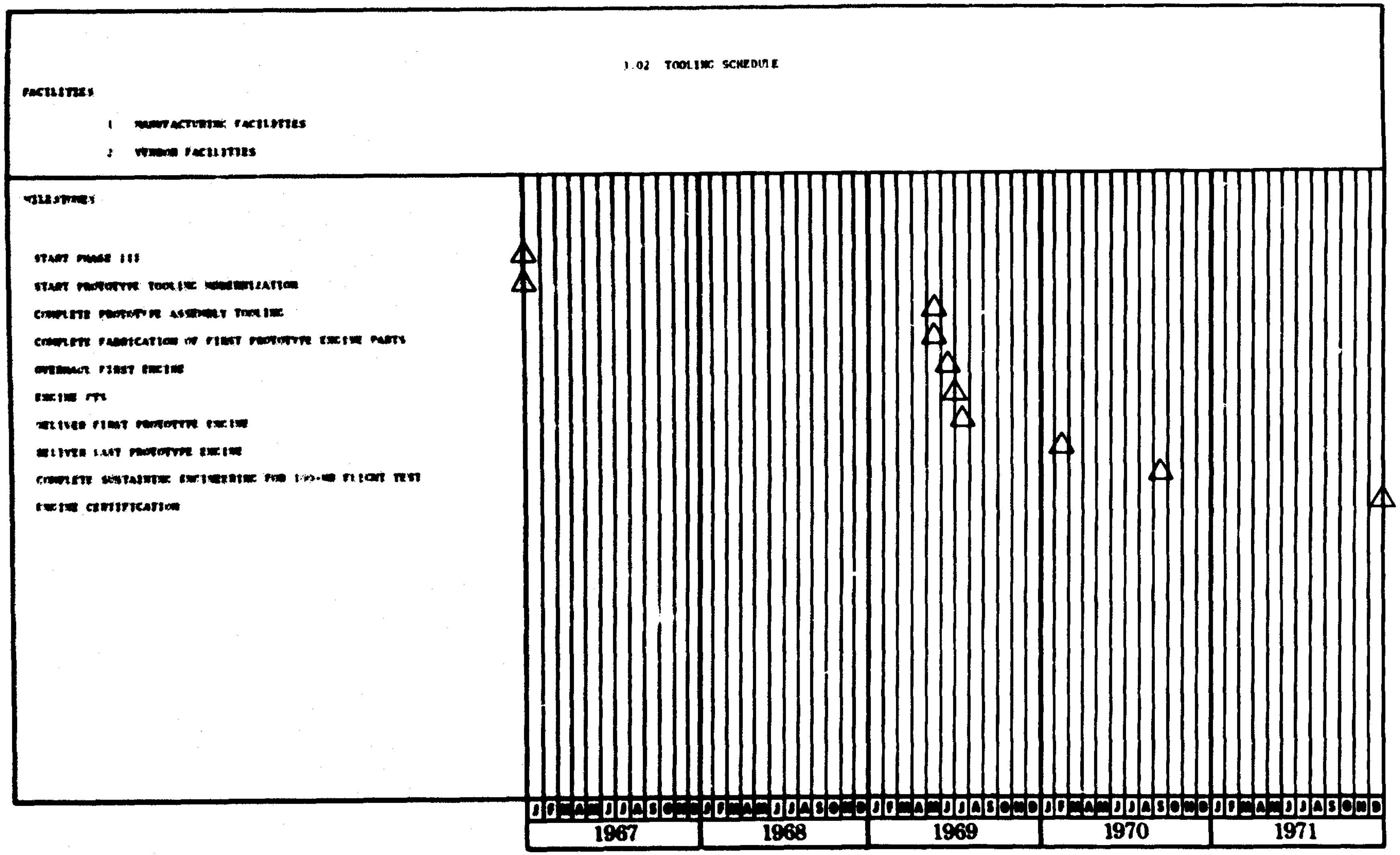

Figure 3. 3.02 Tooling

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VII

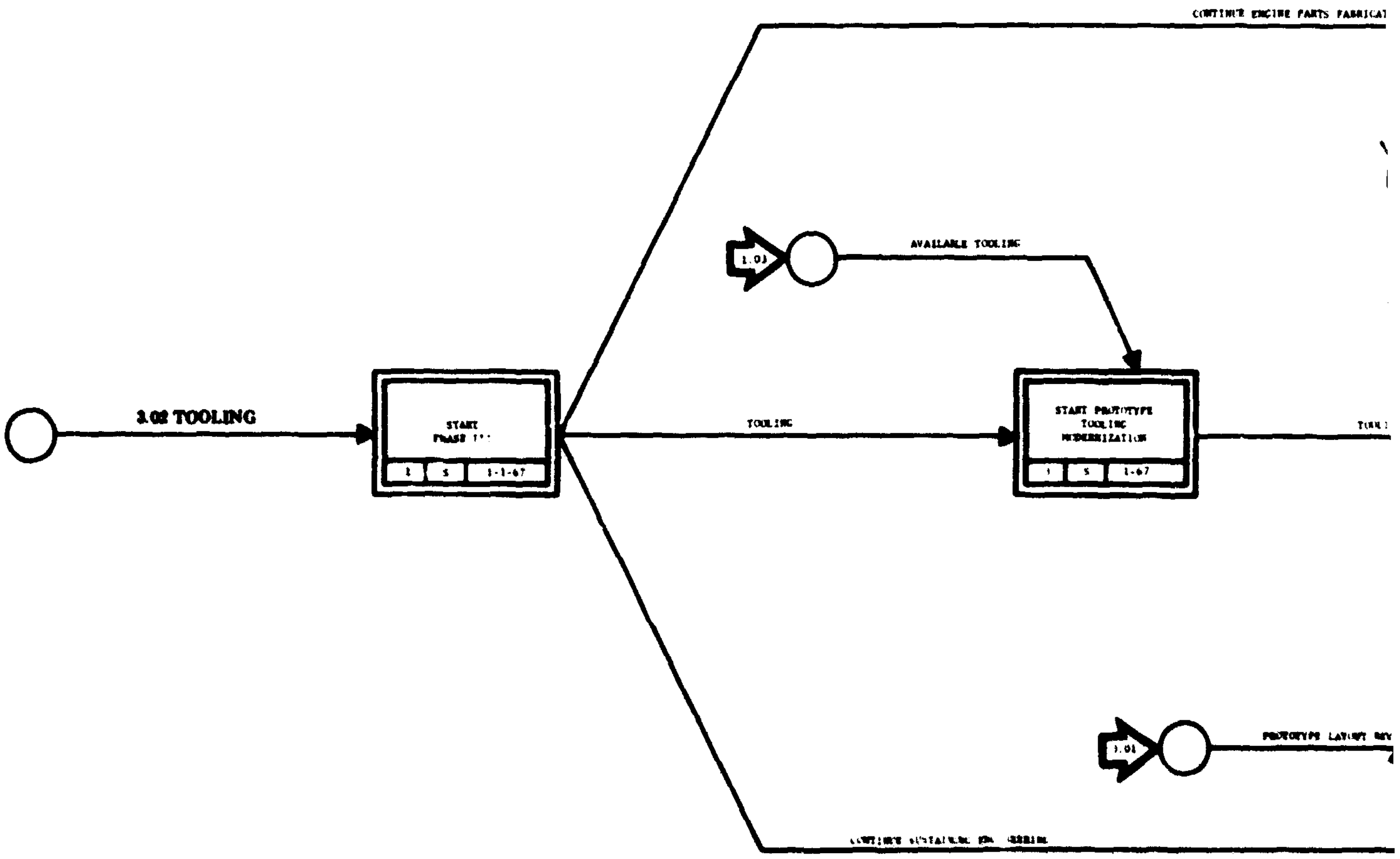
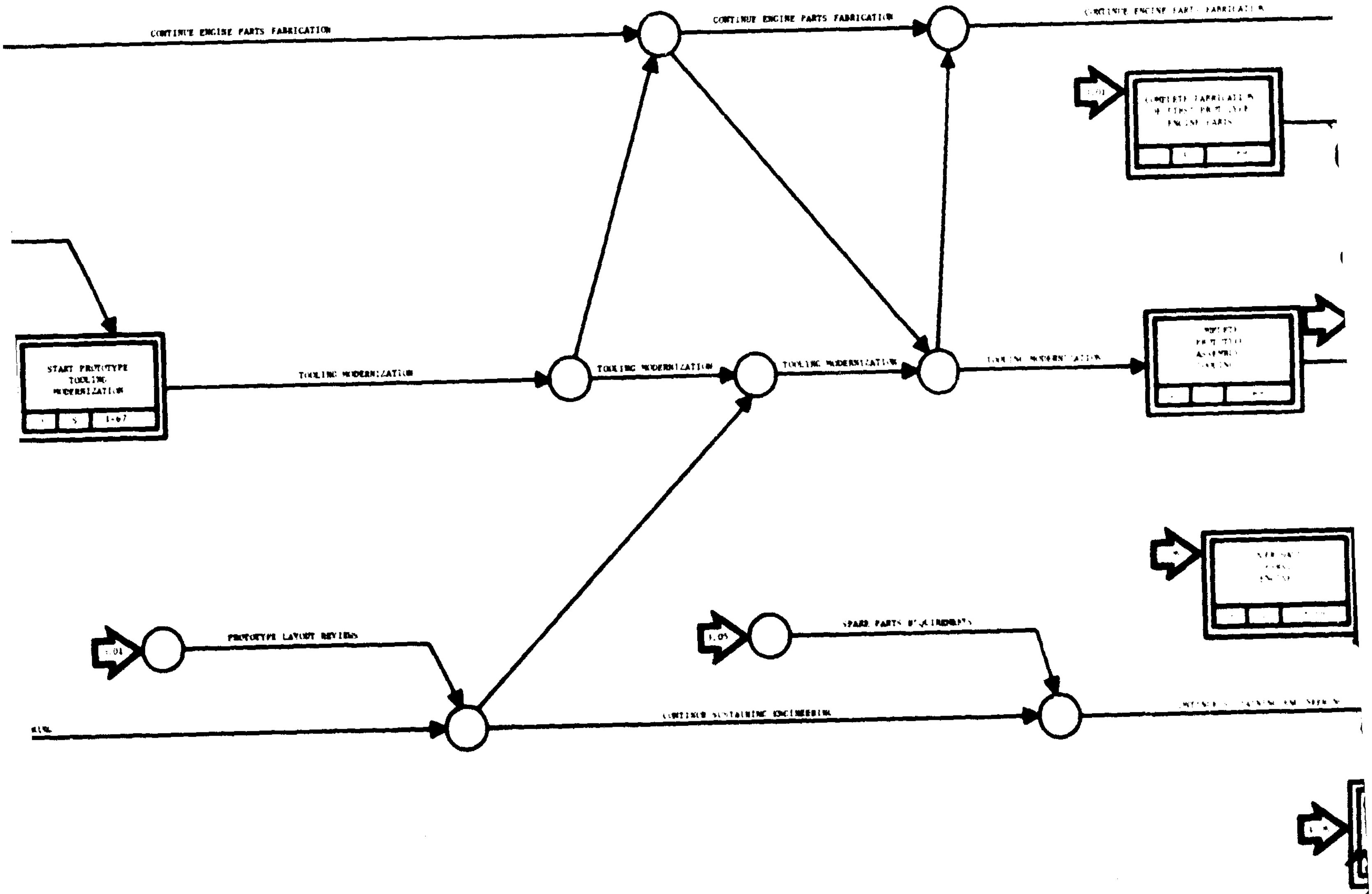


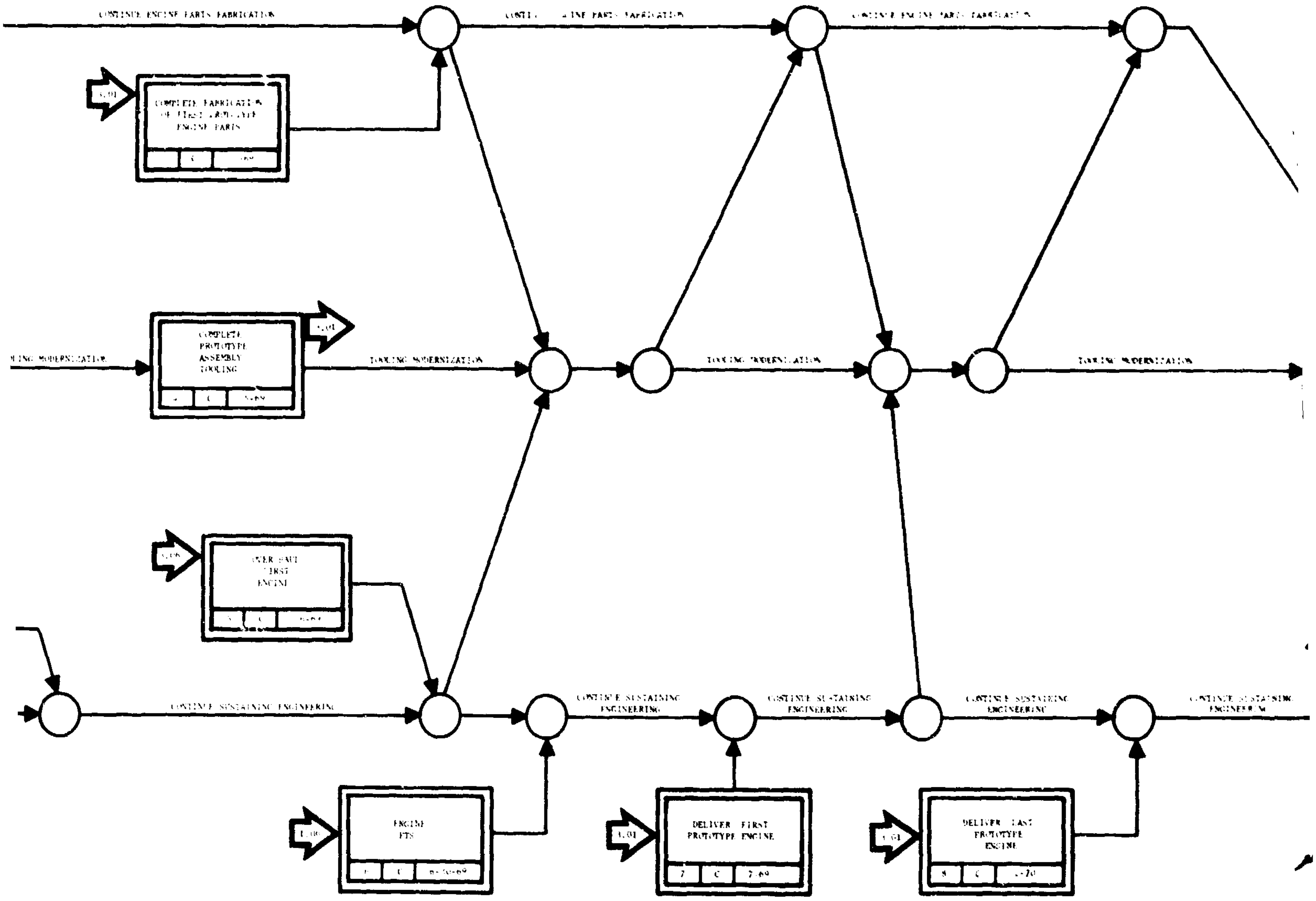
Figure 4. 3.02 Tooling

3.02 Tooling

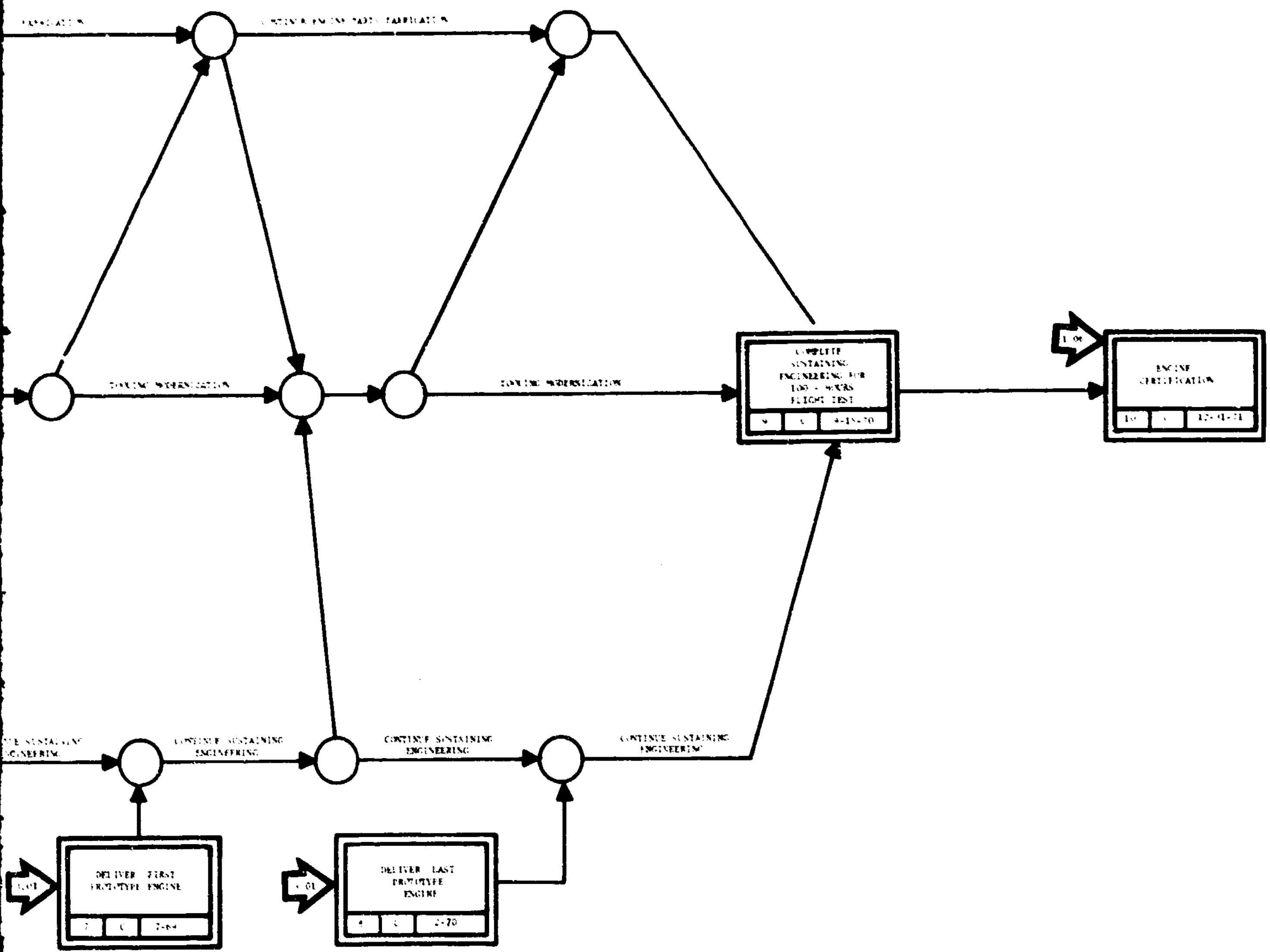


2

Tooling



CONTINUE ENGINE PARTS FABRICATION
TOOLING MODERNIZATION
CONTINUE SUSTAINING ENGINEERING
COMPLETE PROTOTYPE ASSEMBLY TOOLING
DELIVER FIRST PROTOTYPE ENGINE
7 C 7-69
DELIVER LAST PROTOTYPE ENGINE


CONTINUE SUSTAINING ENGINEERING
CONTINUE SUSTAINING ENGINEERING
CONTINUE SUSTAINING ENGINEERING
DELIVER FIRST PROTOTYPE ENGINE
DELIVER LAST PROTOTYPE ENGINE
2-70
COMPLETE SUSTAINING ENGINEERING FOR
FLIGHT TEST
ENGINE CERTIFICATION

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VH

3.03 ENGINE PERFORMANCE

Performance analysis of the JTF17 ground, taxi, and flight test engines during Phase III will include reduction, processing and analysis of overall engine performance data with respect to thrust, specific fuel consumption, augmentation, efficiency distortion, cooling, heat rejection, starting characteristics and windmilling characteristics. Analysis and evaluation of inlet/engine/exhaust system compatibility and reverser performance are also an integral part of this effort. The performance effort also includes analysis and evaluation of the Acceptance Test data on new prototype and overhaul engines to ensure compliance to engine specification requirements.

The total performance analysis effort described in detail for development engines (Reference Section 1.07 of this Detail Work Plan) will be applied to the ground, taxi, and flight test engines. Test planning and integration of engine performance is presented in Test, Volume IV, Report E.

The major milestones, network chart and event dictionary for engine performance are shown in figures 5 and 6, respectively.

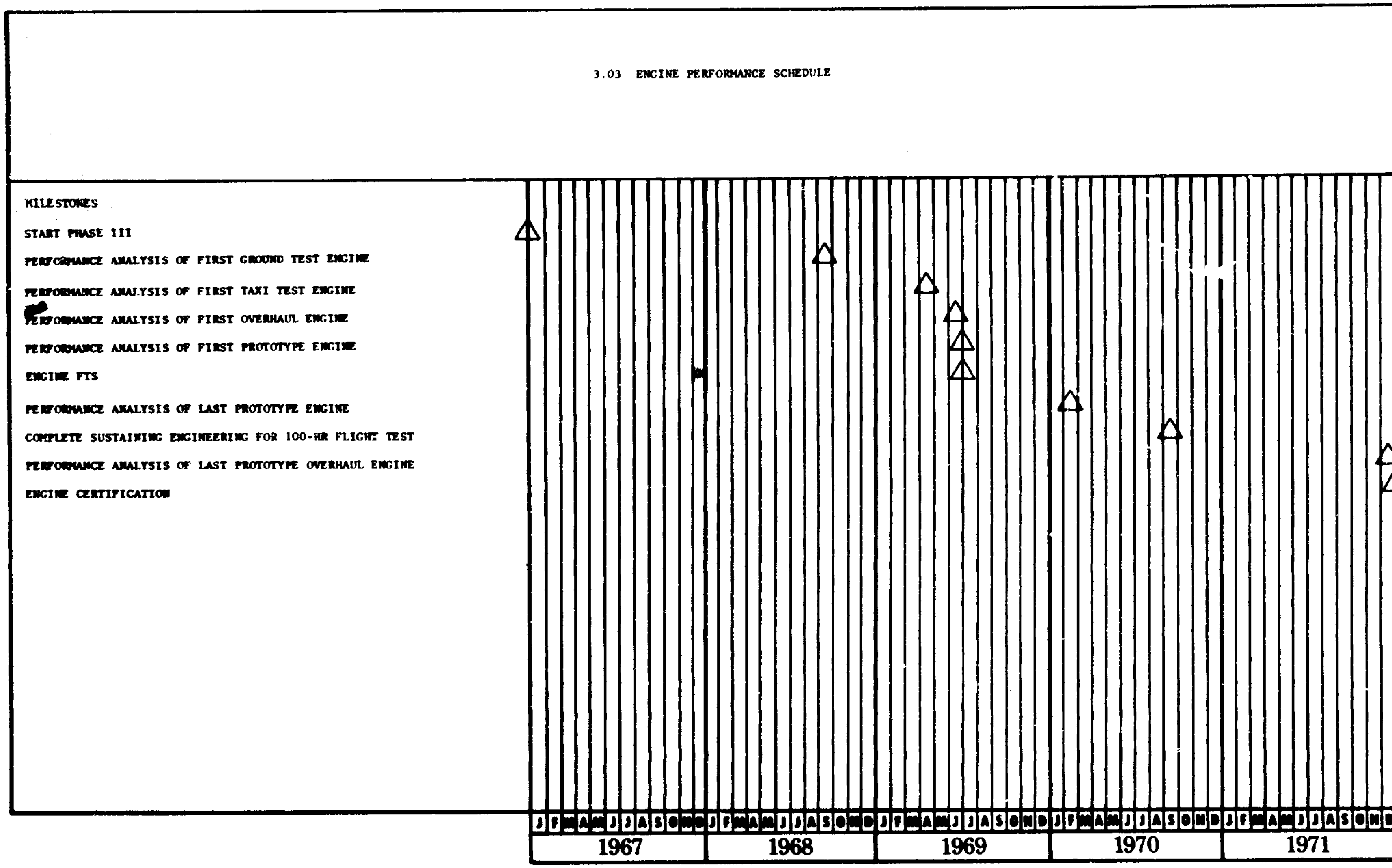

Figure 5. 3.03 Engine Performance

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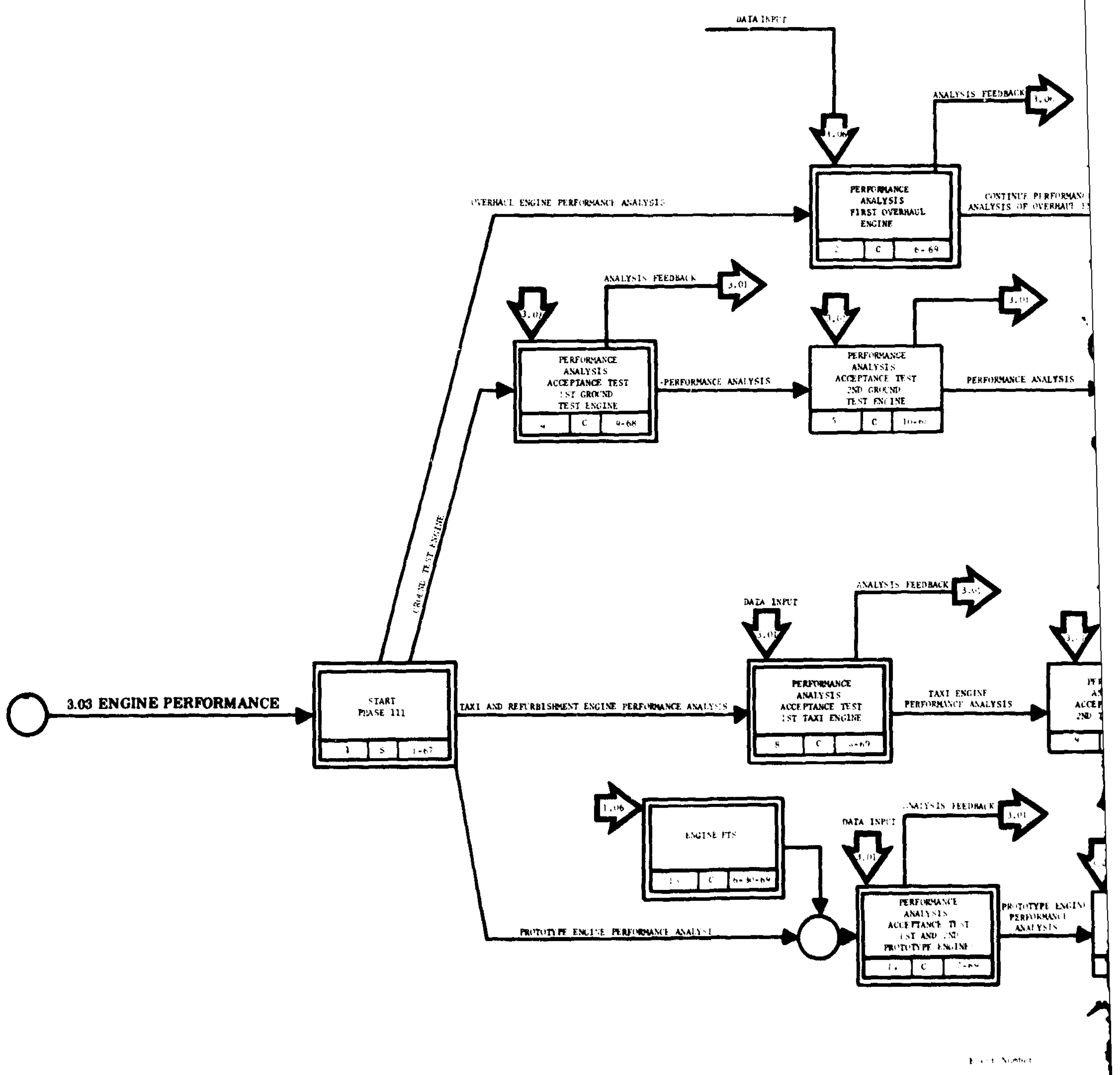
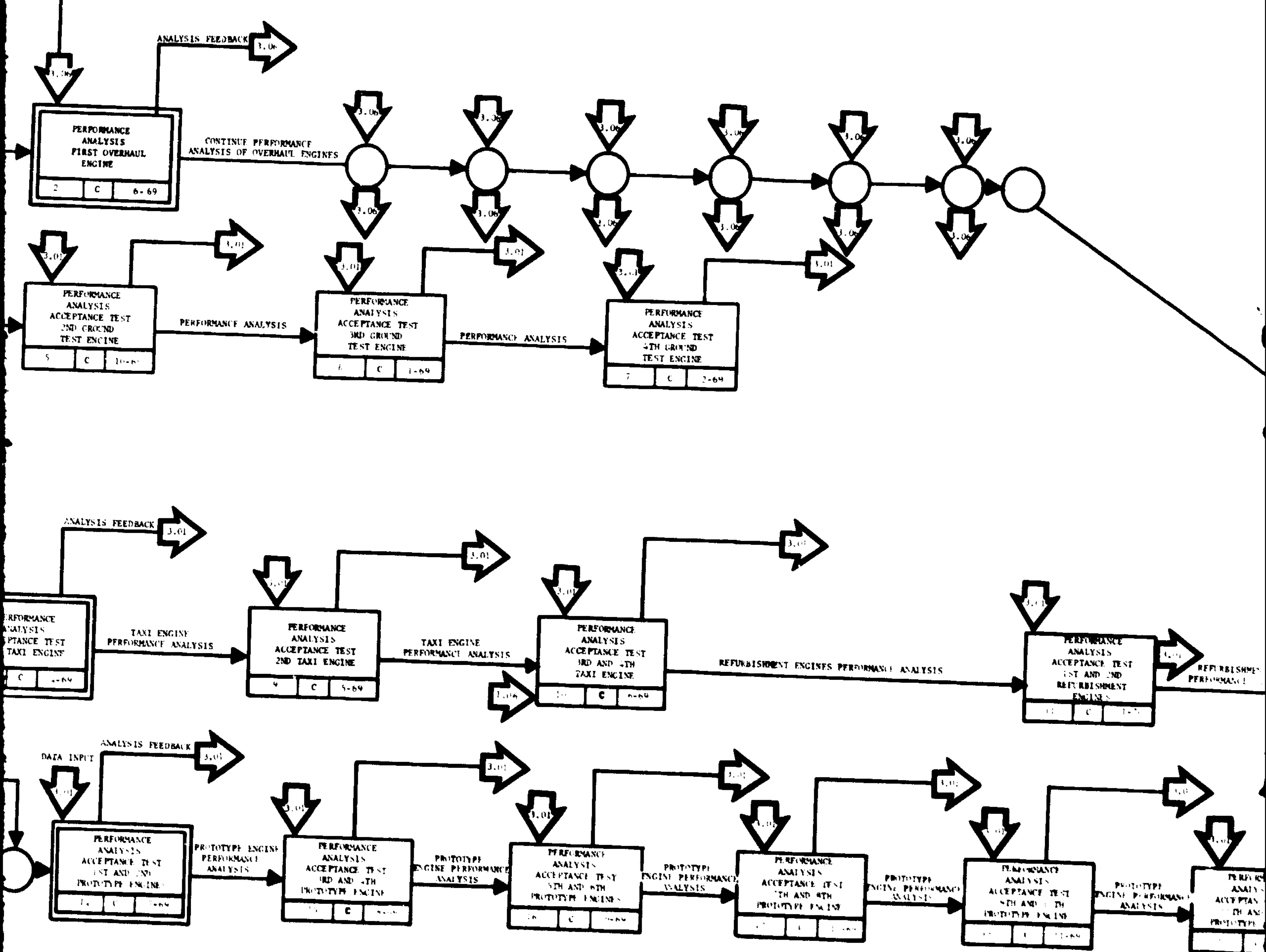


Figure 6. 3.03 Engine Performance

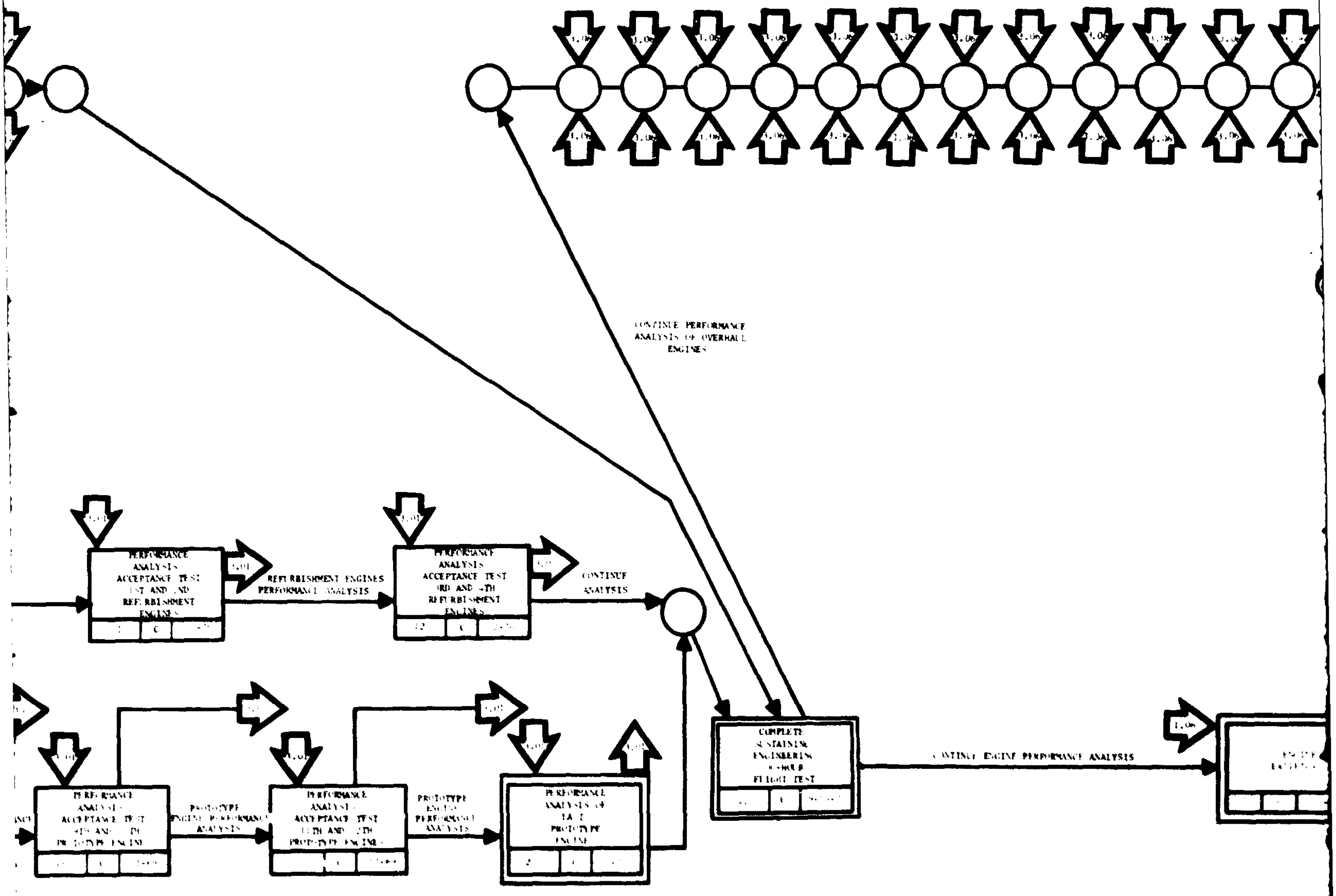
3.03 Engine Performance



EVENT DICTIONARY
ENGINE PERFORMANCE

Event Number	Description and Criteria	Event Number	Description and Criteria	Event Number
	START PHASE III Phase III [illegible]		PERFORMANCE ANALYSIS ACCEPTANCE TEST FOURTH GROUND TEST ENGINE [illegible] Report the results of data analysis.	
	PERFORMANCE ANALYSIS OF FIRST OVERHAUL ENGINE Complete the performance analysis of the acceptance test data from the first overhaul engine. Report the results of data analysis.		PERFORMANCE ANALYSIS ACCEPTANCE TEST FIRST TAXI ENGINE [illegible]	
	PERFORMANCE ANALYSIS OF LAST PROTOTYPE OVERHAUL ENGINE Complete the performance analysis of acceptance test data from the last prototype overhaul engine. Report the results of data analysis.		PERFORMANCE ANALYSIS ACCEPTANCE TEST [illegible] ENGINE [illegible] Report the results of data analysis.	
	PERFORMANCE ANALYSIS ACCEPTANCE TEST FIRST GROUND TEST ENGINE [illegible] Report the results of data analysis.		PERFORMANCE ANALYSIS ACCEPTANCE TEST [illegible] FOURTH TAXI ENGINE [illegible]	
	PERFORMANCE ANALYSIS ACCEPTANCE TEST SECOND GROUND TEST ENGINE Complete the performance analysis of the acceptance test data from the second ground test engine. Report the results of data analysis.		PERFORMANCE ANALYSIS ACCEPTANCE [illegible] REFURBISHMENT ENGINE [illegible] Report the results of data analysis.	
	PERFORMANCE ANALYSIS ACCEPTANCE TEST THIRD GROUND TEST ENGINE Complete the performance analysis of the acceptance test data from the third ground test engine. Report the results of data analysis.			

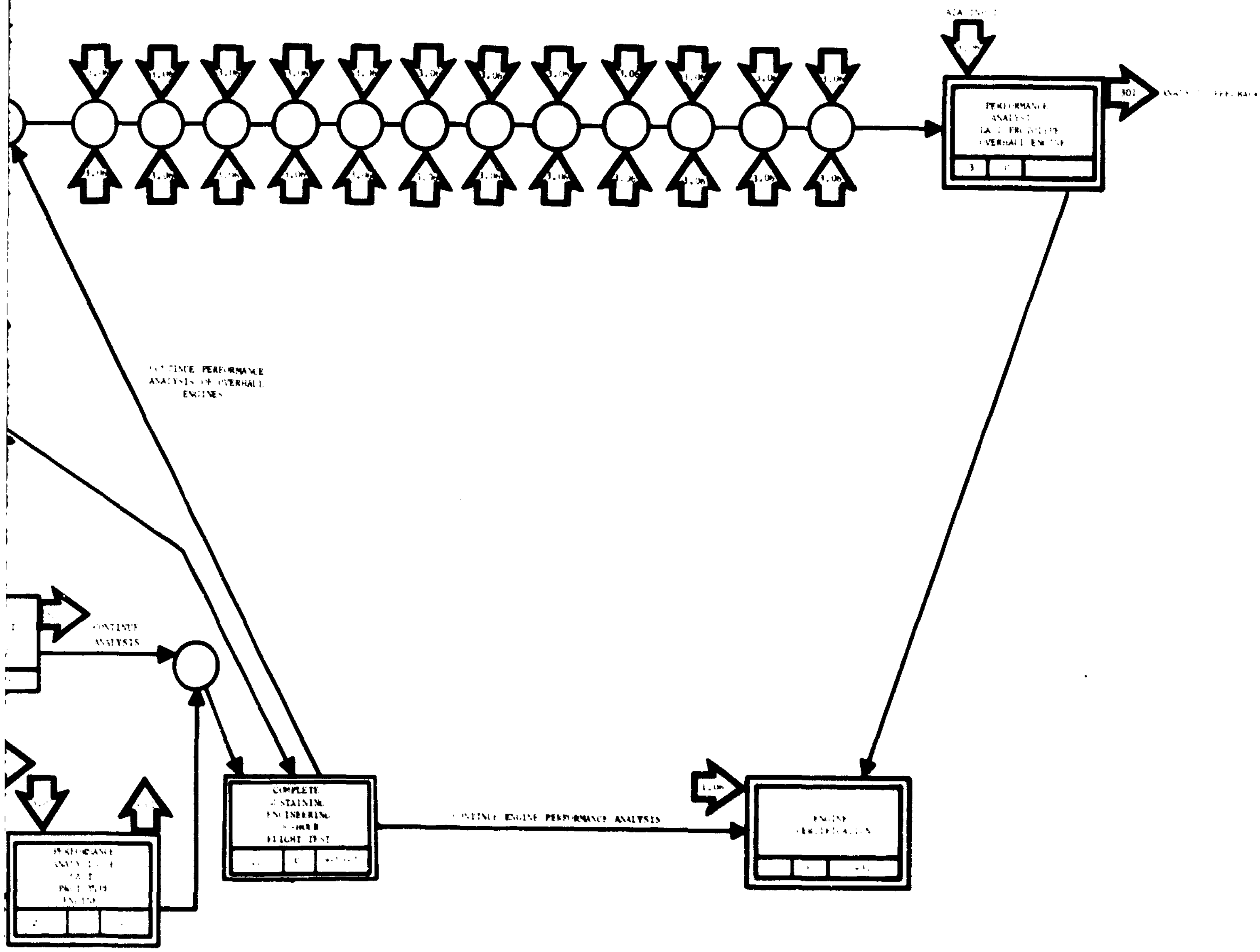
rformance



Event Number

Description

3



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VII

4

3.04 ENGINE MOCKUP

During Phase III, the JTF17 engine program will require continued modification of the Phase II-C engineering mockups and engine installation mockups delivered to the airframe contractor. New mockups will be designed, fabricated and assembled to meet the requirements of a Class III installation design engine which will duplicate overall size, contour, external details of the actual engine design within manufacturing tolerances. Class II engine installation mockups will be fabricated and assembled for The Boeing Company's requirements only to provide overall size and contour, but the extent of completeness and the tolerance control will be accomplished to a lesser degree. This program will provide the airframe manufacturer with the most useful and complete engine installation mockup so that a full-scale, three-dimensional conception of the engine exterior configurations is obtained. Practical solutions of general configuration details covering operational suitability, reliability, safety, accessibility, and maintainability will be obtained throughout the design and development of the engine installation.

The design and construction of the engineering and installation mockups will conform to general procedures of ANA Bulletin 406-A, including identification of pertinent parts and sections of the engine and color coding of components and accessories. The engine mockups will be constructed of metal and fiberglass-reinforced plastics with the use of hardwood limited to Class II engine mockups only. The engine-airframe interface boundary will be highlighted by color code and servicing points.

The major milestones, network chart and event dictionary for the engine mockup program are shown in figures 7 and 8, respectively.

A detailed description of the engine mockup program is presented in the Mockup Plan, Volume III, Report D, Section I. Test planning and integration of engine mockup is presented in Test, Volume IV, Report E.

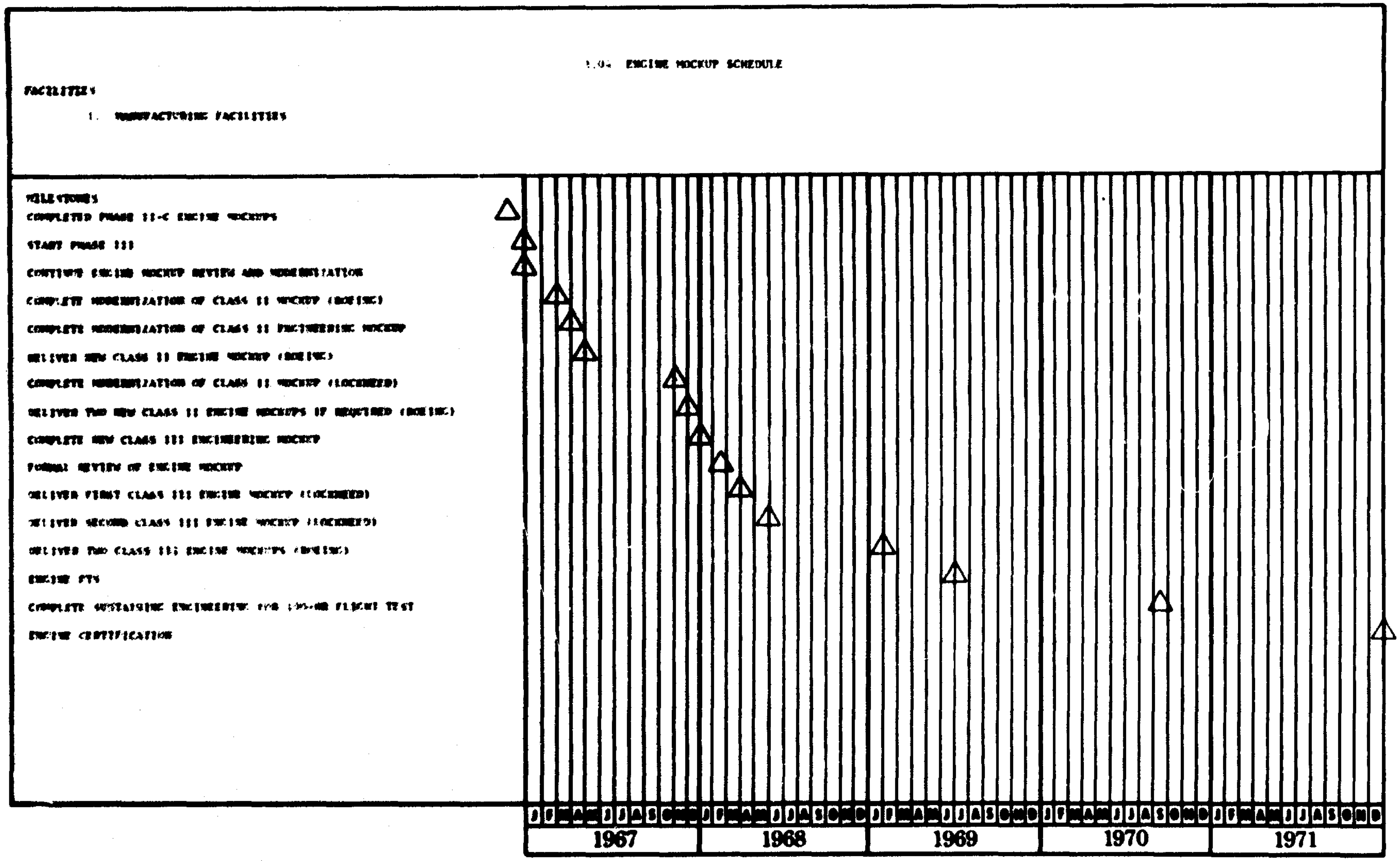

Figure 7. 3.04 Engine Mockup

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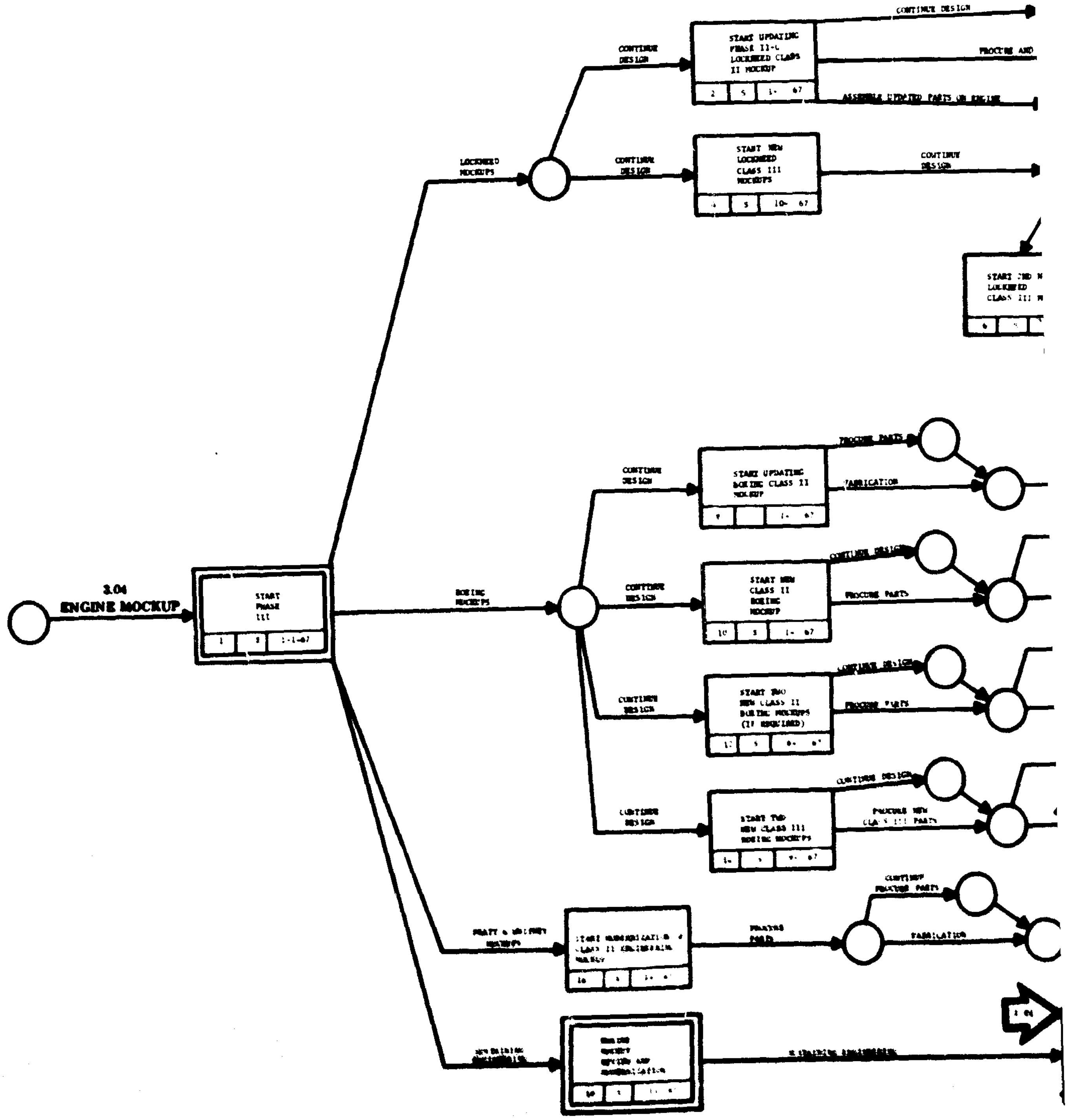
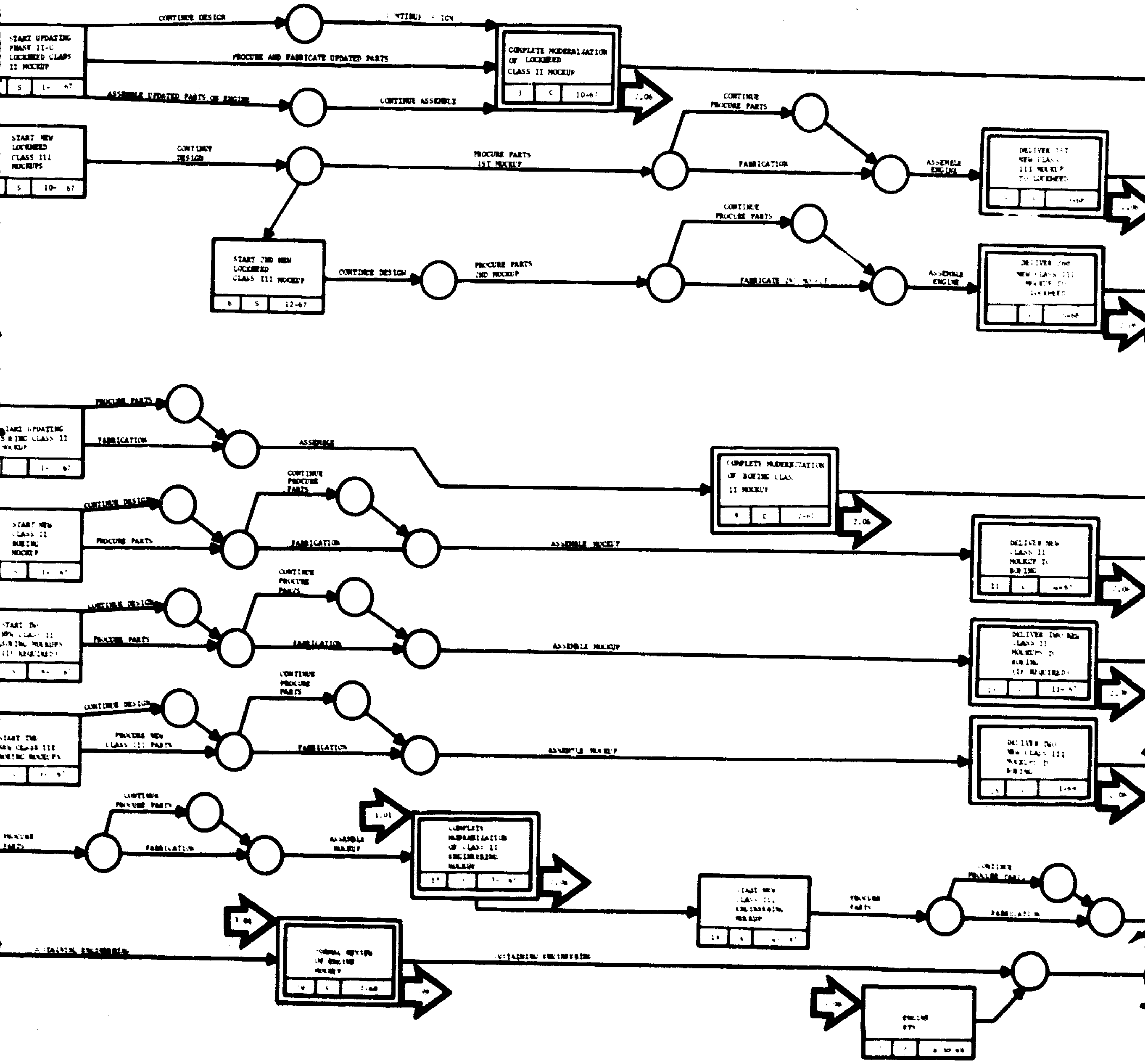


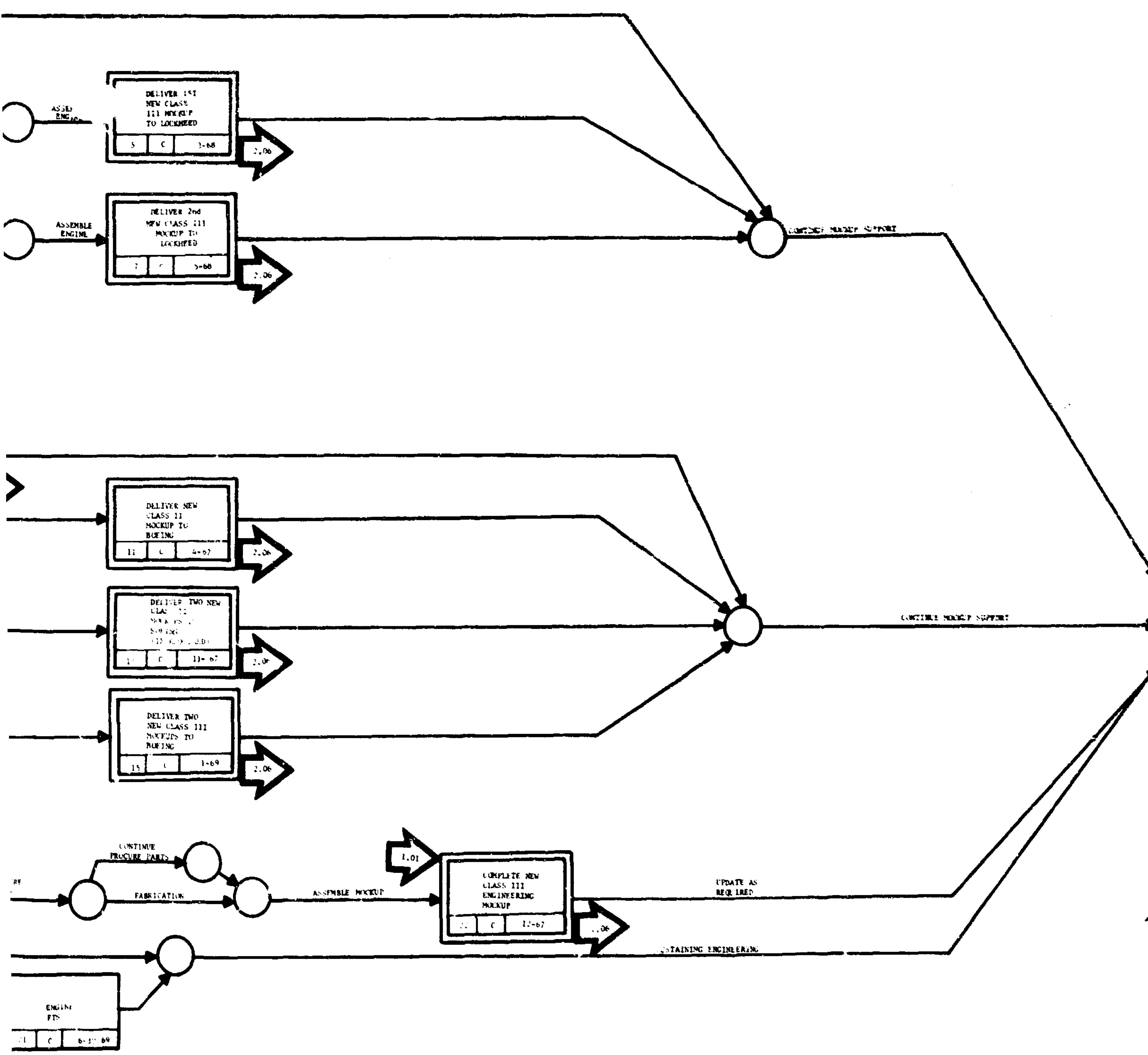
Figure 8. 3.04 Engine Mockup

3.04 Mockups



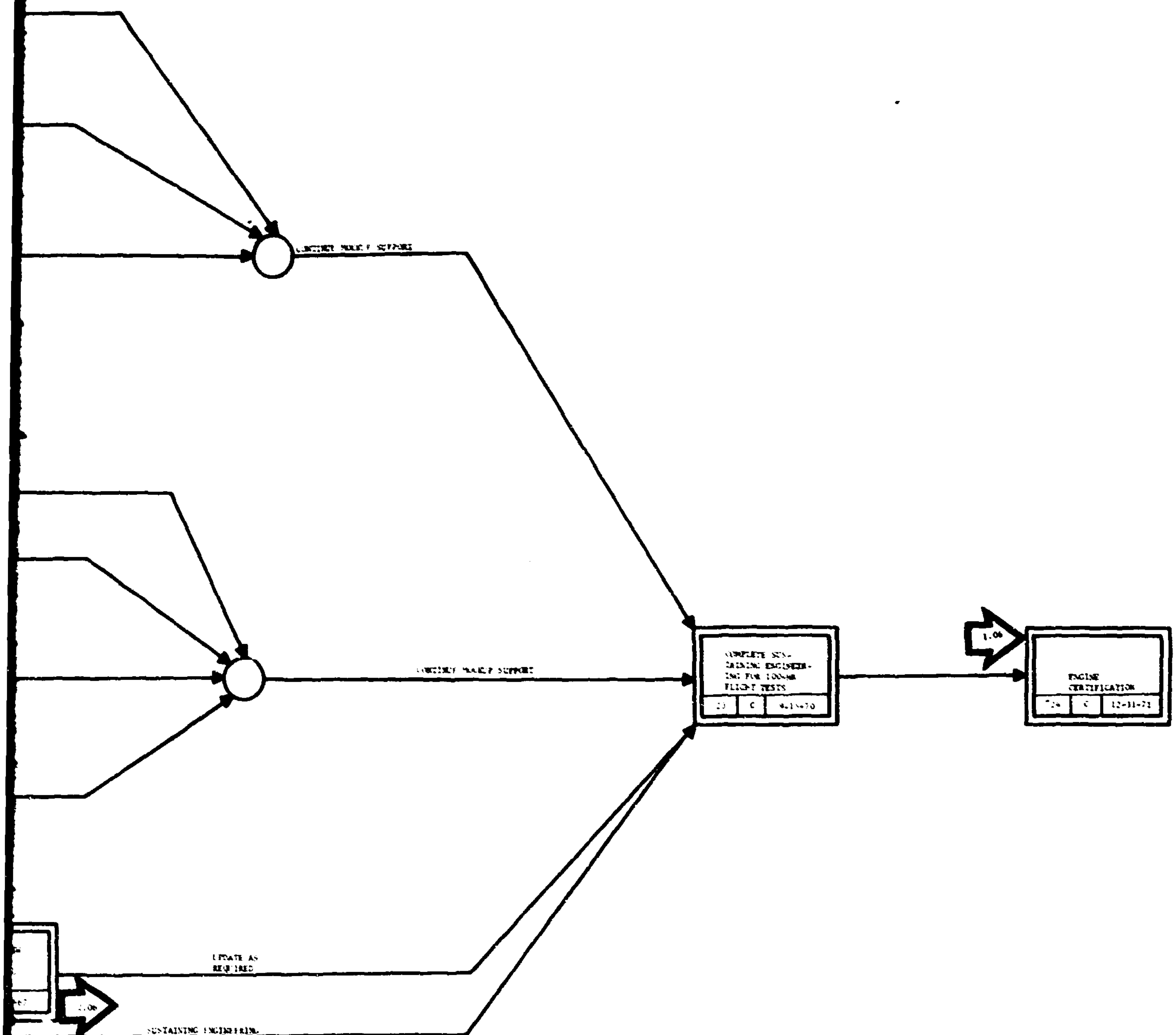
CONTINUE DESIGN
START UPDATING PHASE II-C LOCKHEED CLASS II MOCKUP
PROCURE AND FABRICATE UPDATED PARTS
COMPLETE MODERNIZATION OF LOCKHEED CLASS II MOCKUP
ASSEMBLE UPDATED PARTS ON ENGINE
CONTINUE ASSEMBLY
START NEW LOCKHEED CLASS III MOCKUPS
CONTINUE DESIGN
PROCURE PARTS 1ST MOCKUP
CONTINUE PROCURE PARTS
FABRICATION
ASSEMBLE ENGINE
START 2ND NEW LOCKHEED CLASS III MOCKUP
CONTINUE DESIGN
PROCURE PARTS 2ND MOCKUP
PROCURE PARTS
FABRICATION
ASSEMBLE
COMPLETE MODERNIZATION OF BOEING CLASS II MOCKUP
CONTINUE DESIGN
CONTINUE PROCURE PARTS
START NEW CLASS II BOEING MOCKUP
ASSEMBLE MOCKUP
ASSEMBLE MOCKUP
PROCURE NEW CLASS III PARTS
FABRICATION
CONTINUE PROCURE PARTS
FABRICATION
SUSTAINING ENGINEERING

Mockups



EVENT DICTIONARY
ENGINE MOCKUP

Description and Criteria	Event Number	Description and Criteria	Event Number	Description and Criteria
START NEW CLASS II BOEING MOCKUP [illegible] design and procure parts for first [illegible] Class II Boeing mockup. Parts procurement [illegible] progress.	[illegible]	DELIVER TWO NEW CLASS III MOCKUPS TO BOEING Complete assembly of two new Class III mockups. Two Class III mockups are shipped to Boeing.	[illegible]	FORMAL REVIEW OF ENGINE MOCKUP Conduct a review of Class III [illegible] mockup. Complete the review.
DELIVER NEW CLASS II MOCKUP TO BOEING [illegible]	[illegible]	START MODERNIZATION OF CLASS II ENGINEERING MOCKUP Continue design and procure parts for converting Phase II Engineering Mockup to a Class II mockup. Parts procurement is in progress.	[illegible]	ENGINE FTS Reference engine network [illegible] for description and criteria.
START TWO NEW CLASS II BOEING MOCKUPS (IF REQUIRED) [illegible]	[illegible]	COMPLETE MODERNIZATION OF CLASS II ENGINEERING MOCKUP Assemble Class II Engineering mockup. Completed assembly is ready for review.	[illegible]	COMPLETE NEW CLASS III ENGINEERING MOCKUP Assemble Phase III Engineering mockup. Completed assembly [illegible] ready for review.
DELIVER TWO NEW CLASS II MOCKUPS TO BOEING (IF REQUIRED) [illegible] shipped to Boeing.	[illegible]	ENGINE MOCKUP REVIEW AND MODERNIZATION Review mockup for modernization to Class II mockup. Complete the review.	[illegible]	COMPLETE SUSTAINING ENGINEERING FOR [illegible] FLIGHT TEST [illegible] Phase III [illegible] flight testing.
START TWO NEW CLASS III BOEING MOCKUPS [illegible] design and procure parts for [illegible] Class III Boeing mockups. Parts procurement [illegible] progress.	[illegible]	START NEW CLASS III ENGINEERING MOCKUP Continue design and procure parts for Class III mockup. Parts procurement is in progress.	[illegible]	ENGINE CERTIFICATION Reference engine network [illegible] for description and criteria.



Description and Criteria

ENGINE CERTIFICATION

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VII

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3.05 SPARES

Selection of spare parts for the JTF17 engine will be based on the judgment and experience of well-qualified personnel having a broad background of knowledge in the areas of maintenance and overhaul of Pratt & Whitney Aircraft engines in current commercial operation and in total support of the J58 Mach 3 engine. The spare parts effort to support the JTF17 engine and the plan for post sales spares support is described in detail in Product Support, Volume IV, Report F, Section VI.

Experience gained during development testing of the JTF17 engine will be utilized to the fullest extent in establishing quantitative spares requirements. All parts selected as spares will be incorporated into a computer-oriented data file which will be continuously updated to reflect the effects of Engineering Change activity.

Approximately 60 days prior to release for manufacture of the prototype JTF17 engines, a spares support list will be prepared by data extraction methods from the computer storage file. In the extraction process a computation of quantitative requirements for JTF17 maintenance and overhaul support will be made and the resulting product will be identified as a Recommended Spare Parts List. This list will be released after review for procurement and delivery at a rate commensurate with delivery of the prototype engines. Procurement or fabrication, inspection and shipment of all spares will be the basic responsibility of the Delivery Material Control Department together with all ancillary departments.

A facility will be established at the flight test site for the purpose of receiving, warehousing and disbursing maintenance spares and to handle the return of repairable items to the FRDC overhaul facility and/or to vendor overhaul facilities. Spare parts representatives will be assigned to man this activity and the maintenance spares inventory will be reviewed and analyzed daily to assure that it will adequately support the flight and ground test programs at the maintenance level. Similarly, the FRDC overhaul and vendor overhaul facilities will include segregated areas to receive, warehouse and disburse all parts required for support of overhaul and repair jobs performed during the prototype engine program.

A computer-oriented data collection and storage system will also be used to summarize all pertinent history relating to the ordering, shipment, usage and inventory balances and values on all parts procured, delivered or on order for support of the prototype engine program. Coincident with this information, a computer-oriented Spare Parts Application Data List will also be compiled and maintained, which will reflect the engineering history and progression of all spare parts applicable to the JTF17 engine.

Spare parts will be scheduled to be available at the ground, flight test and overhaul activities one month prior to commencement of engine operation at each location.

3.06 OVERHAUL

JTF17 engine overhauls required during the ground and flight test programs will be accomplished at the Florida Research and Development Center. The overhaul processes of disassembly, inspection, repair, updating, assembly, and test will be performed by the Engine Delivery Group.

The FRDC overhaul and vendor overhaul facilities will include segregated areas to receive, warehouse and disburse all parts required for the support of engine overhaul during the prototype engine program. By conducting overhauls at our facility, personnel from Project Engineering, Design, Reliability, Maintainability, Human Engineering and other affected groups will be able to observe engine parts condition and overhaul practices and initiate corrective Engineering Change action and/or procedural changes where required.

Detailed reports of engine condition and spare parts usage for each overhaul will be provided.

Technical direction, including extent of disassembly and repair, Engineering Changes to be incorporated, testing to be performed, etc., will be provided, as well as continual monitoring of engines in the overhaul process to avoid delays by anticipating and expediting parts requirements.

The Overhaul Manual will be used during this activity, thereby permitting an evaluation of its various sections throughout Phases III and IV and ensuring a complete and detailed manual for airline operation. In like manner, overhaul tooling will be continually reviewed and will guide the Service Tools and Equipment Group in its final designs of airline overhaul equipment requirements.

The schedule for overhauling engines during the ground test and flight test program of Phase III is as follows:

Engine No.	Overhaul Schedule Completion Date
1	June 1969
2	November 1969
3	January 1970
4	March 1970
5	May 1970
6	June 1970
7	August 1970

The major milestones, network chart and event dictionary for the engine overhaul program are shown in figures 9 and 10, respectively.

A detailed description of the overhaul program is presented in Product Support, Volume IV, Report F, Section VI.

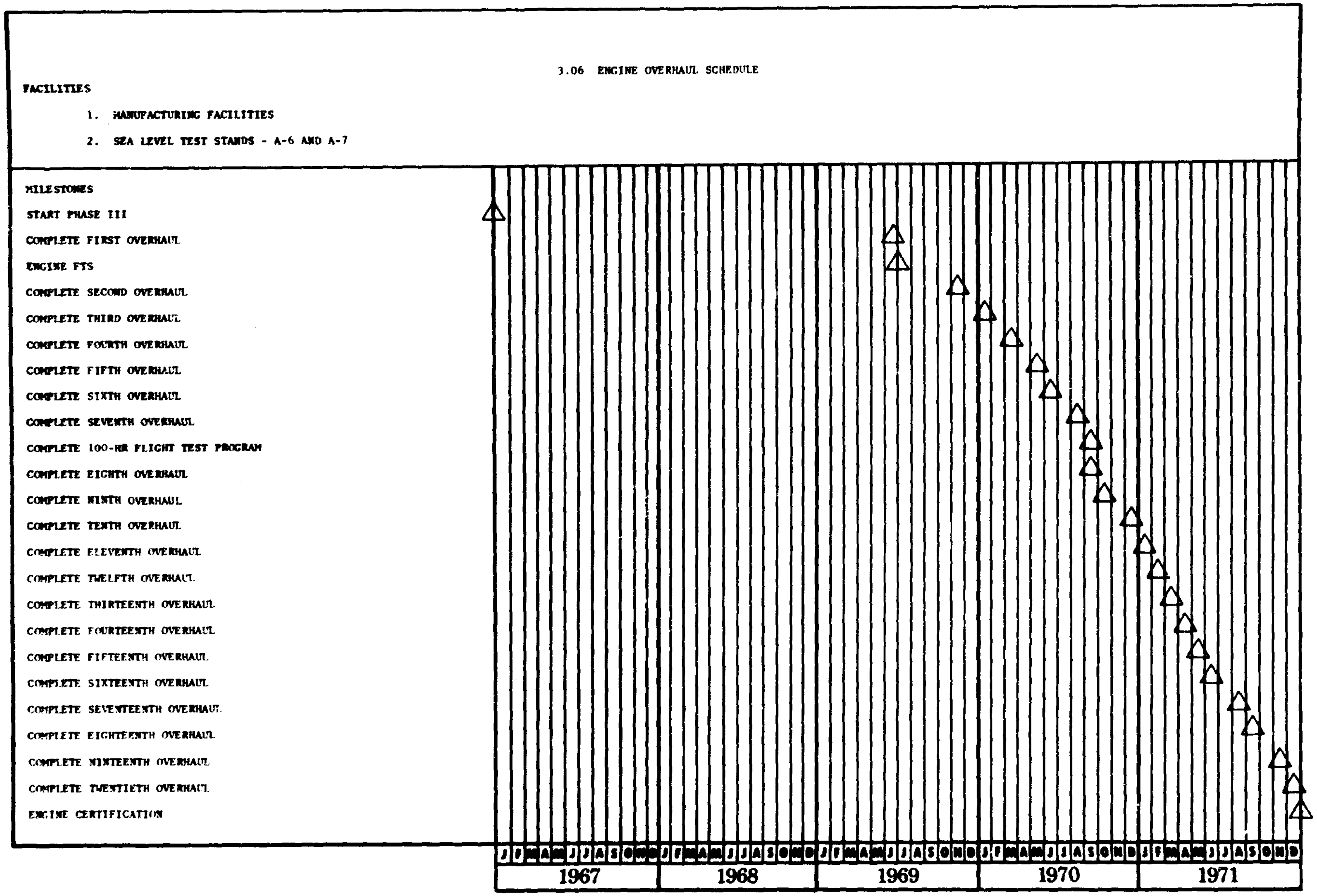

Figure 9. 3.06 Overhaul

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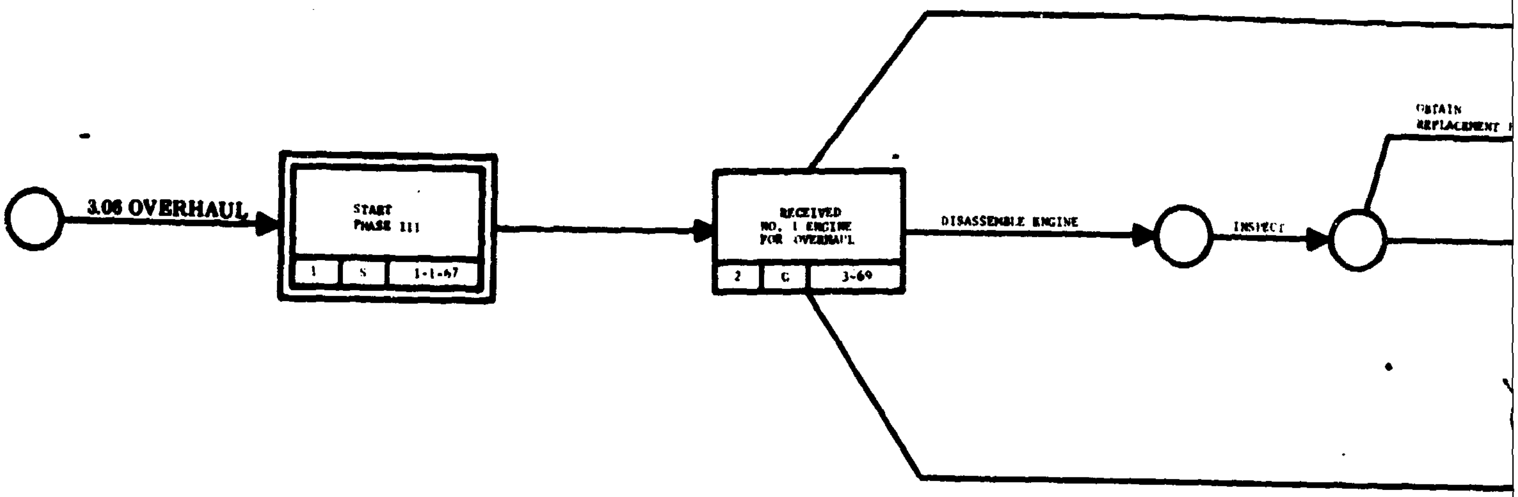
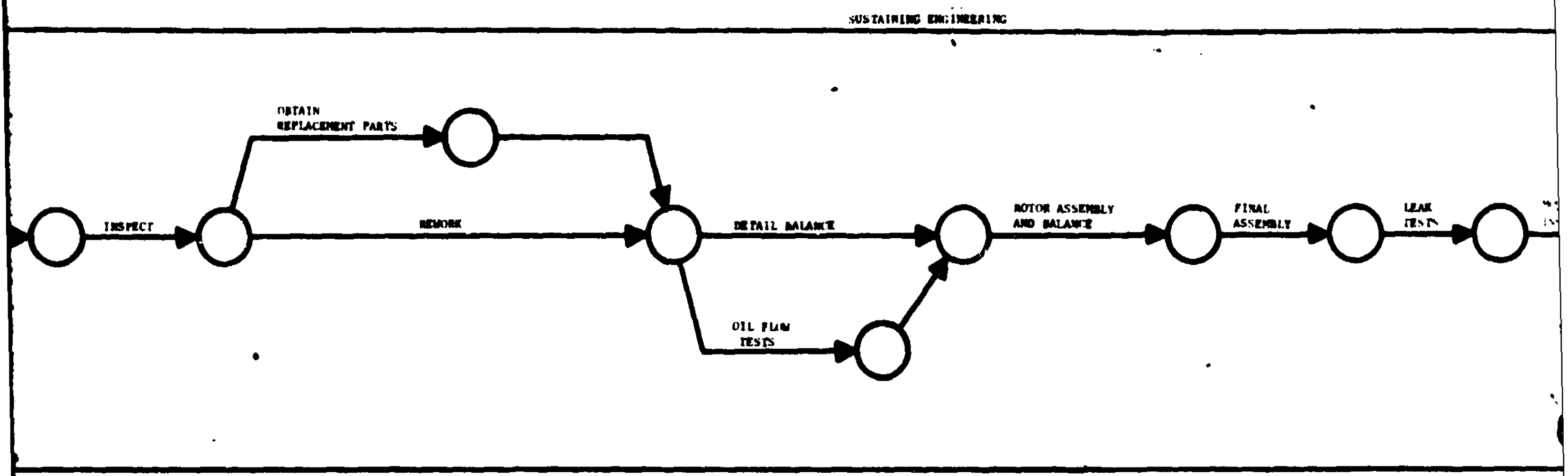
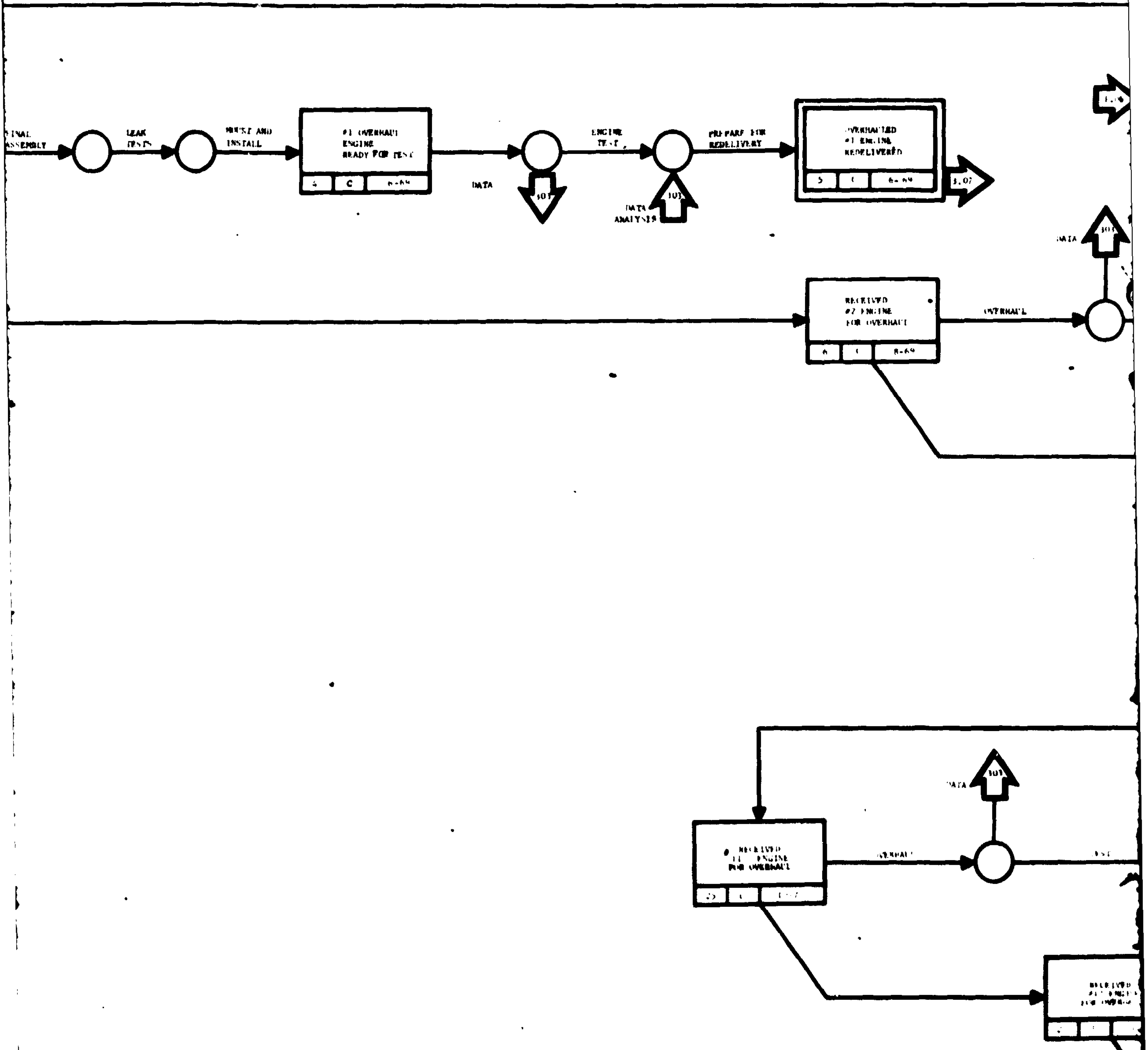


3.06 OVERHAUL
START
PHASE III
1
S
1-1-67
RECEIVED
NO. 1 ENGINE
FOR OVERHAUL
2
C
3-69
DISASSEMBLE ENGINE
INSPECT
OBTAIN
REPLACEMENT


SUSTAINING ENGINEERING
OBTAIN REPLACEMENT PARTS
INSPECT
REWORK
DETAIL BALANCE
OIL FLOW TESTS
ROTOR ASSEMBLY AND BALANCE
FINAL ASSEMBLY
LEAK TESTS

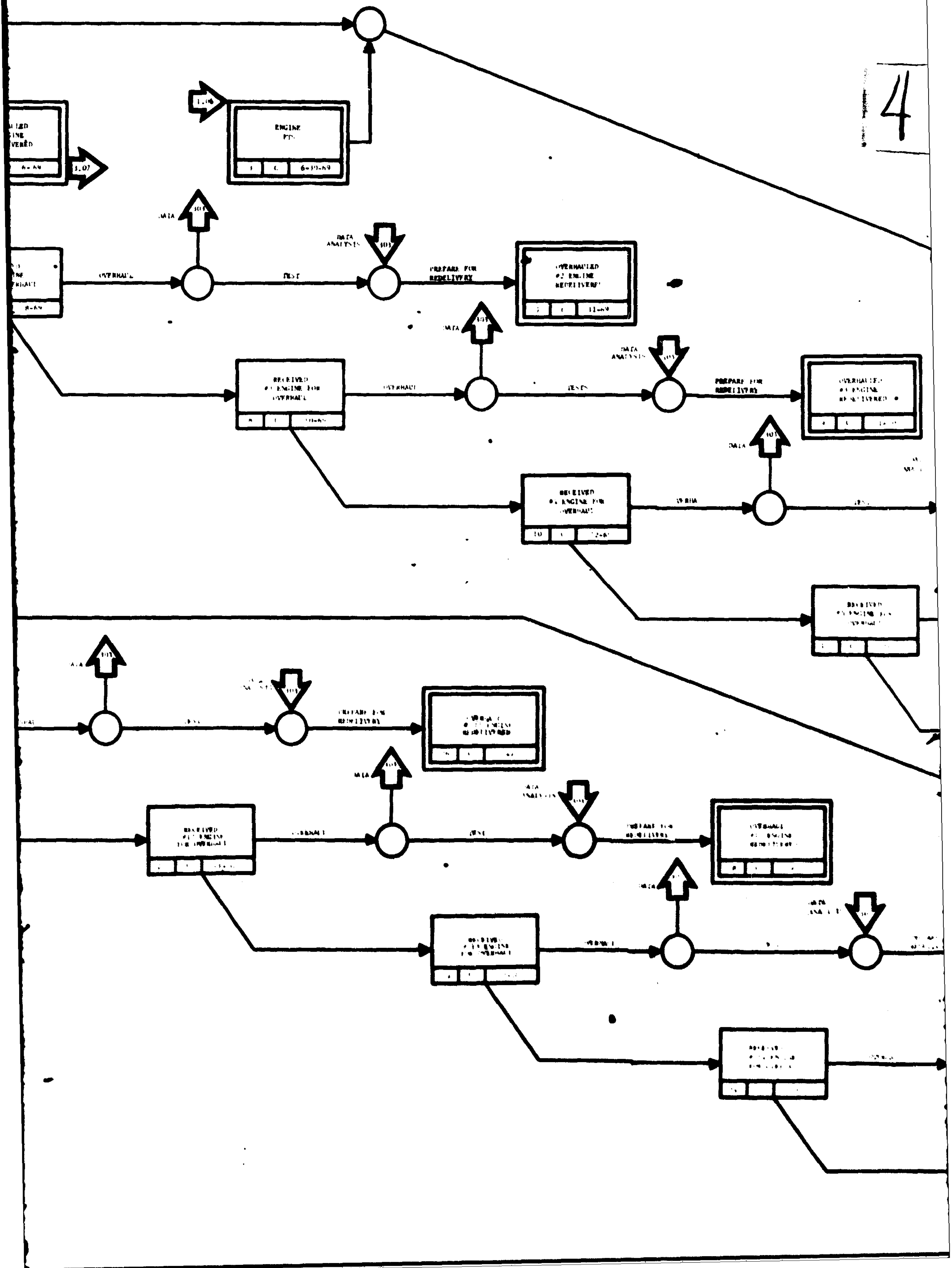
2


LEAK
#1 OVERHAUL
ENGINE
READY FOR TEST
DATA
ENGINE
PREPARE FOR
REDELIVERY
DATA
ANALYSIS
OVERHAULED
#1 ENGINE
REDELIVERED
3.07
DATA
RECEIVED
#2 ENGINE
FOR OVERHAUL
OVERHAUL
6
8-69
DATA

3

3.06 Overhaul

4



3.06 Overhaul

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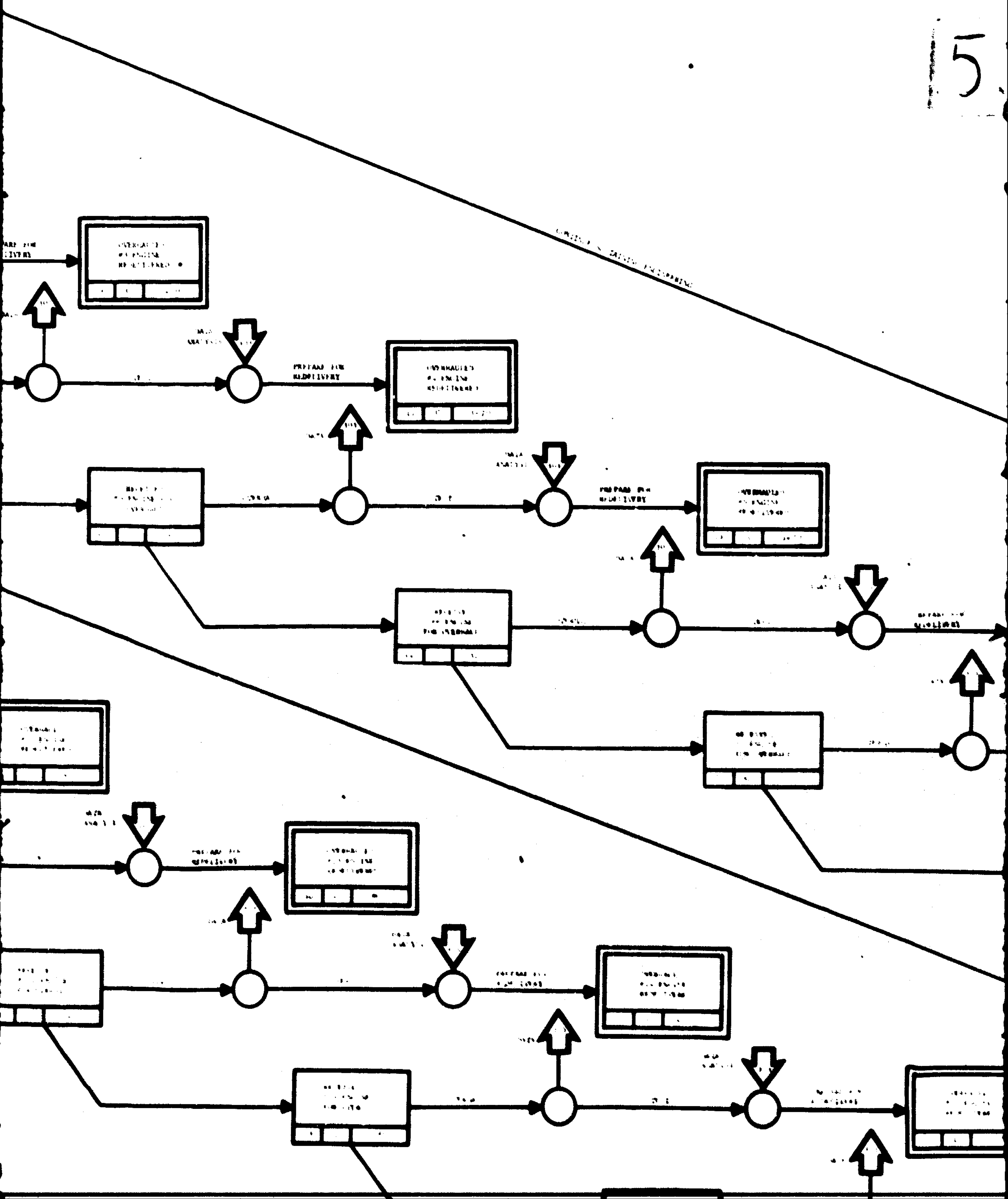

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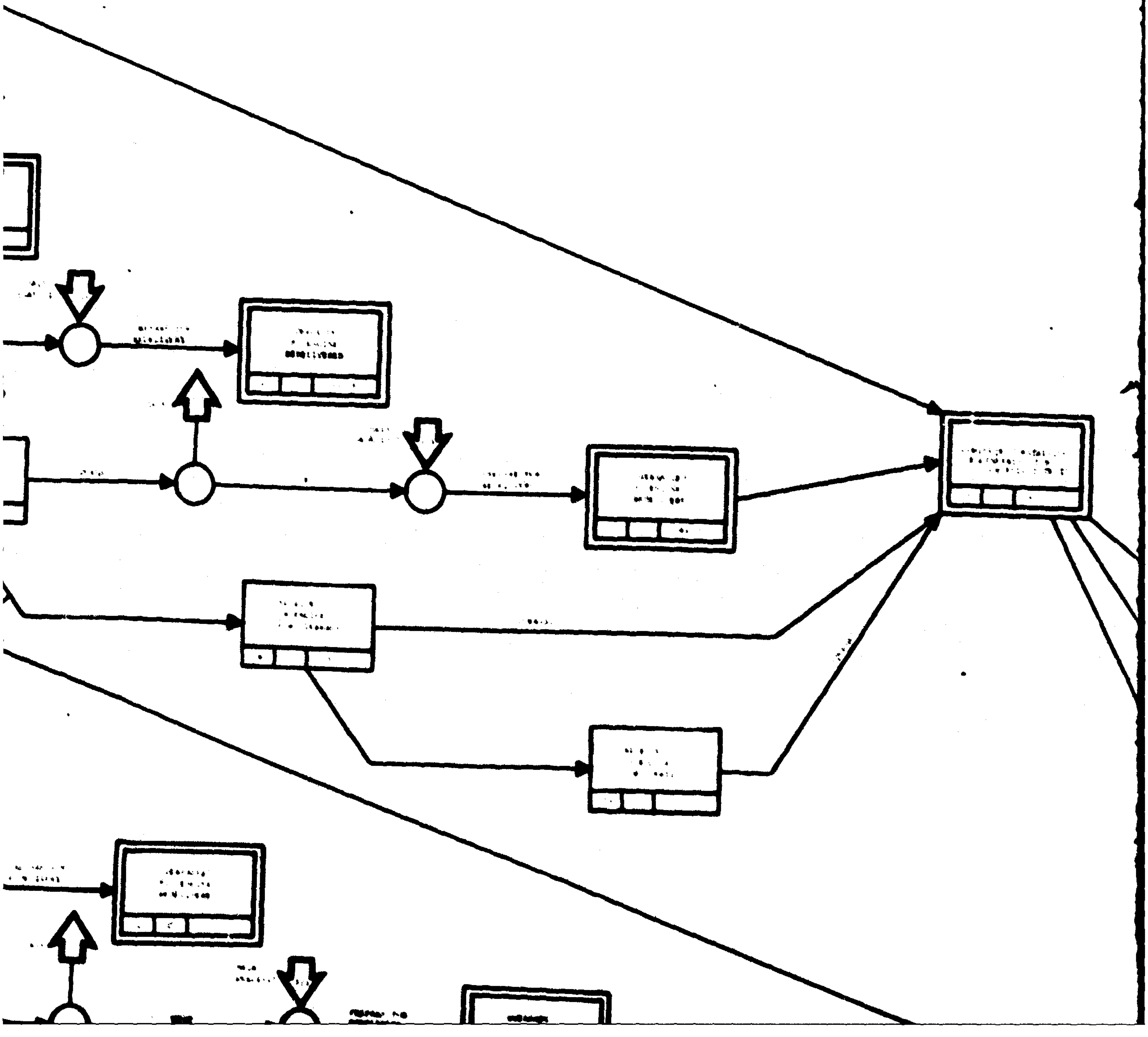

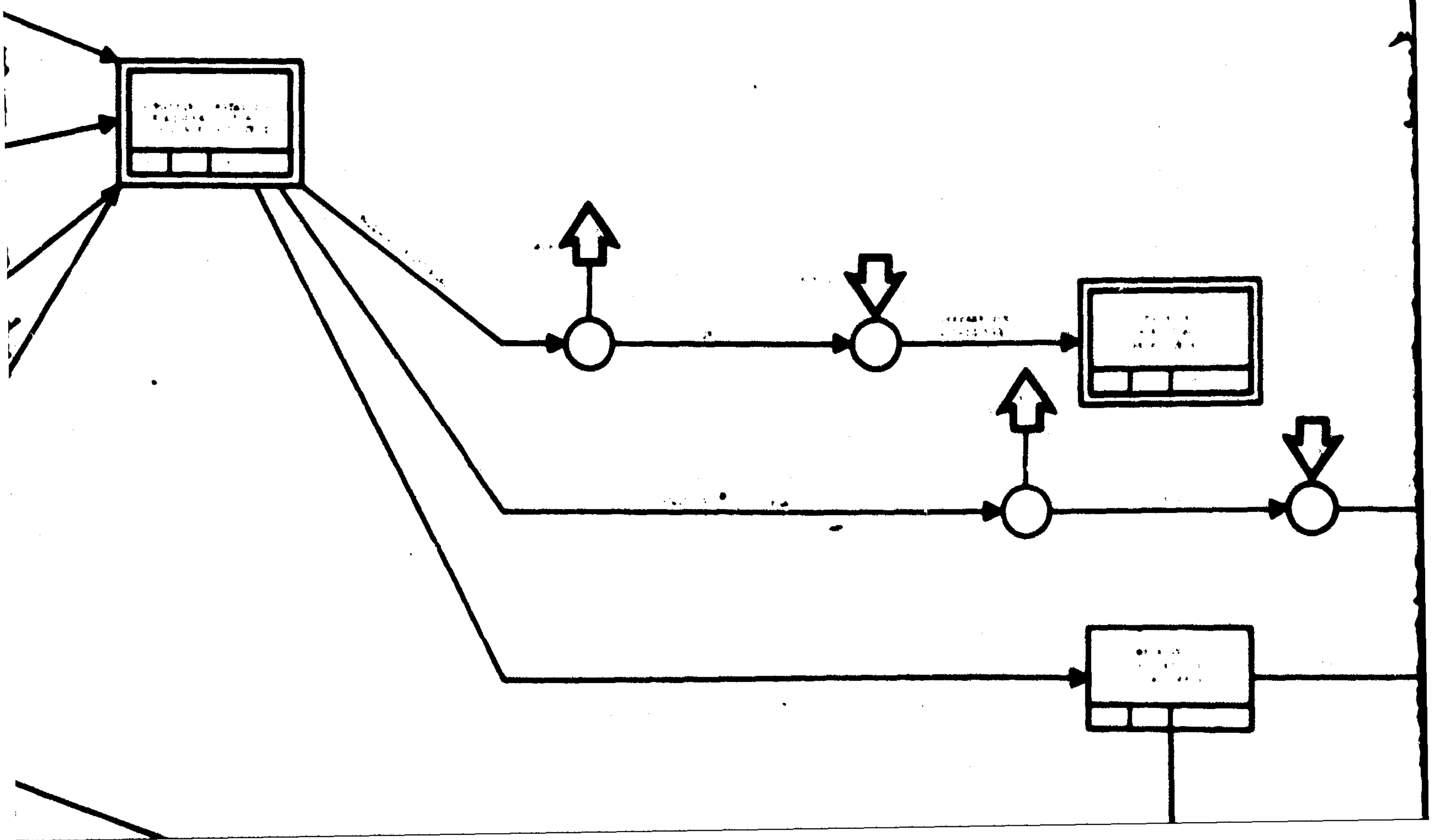

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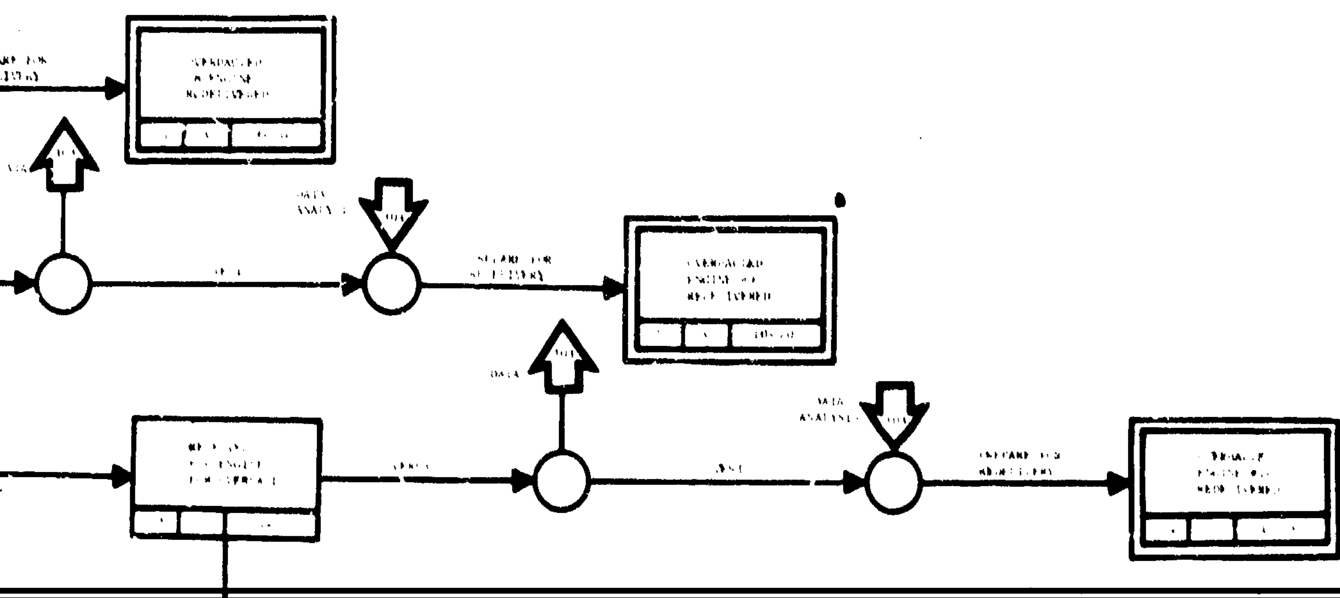
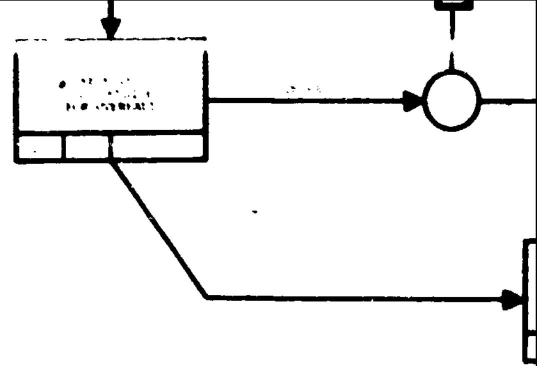
Figure10.





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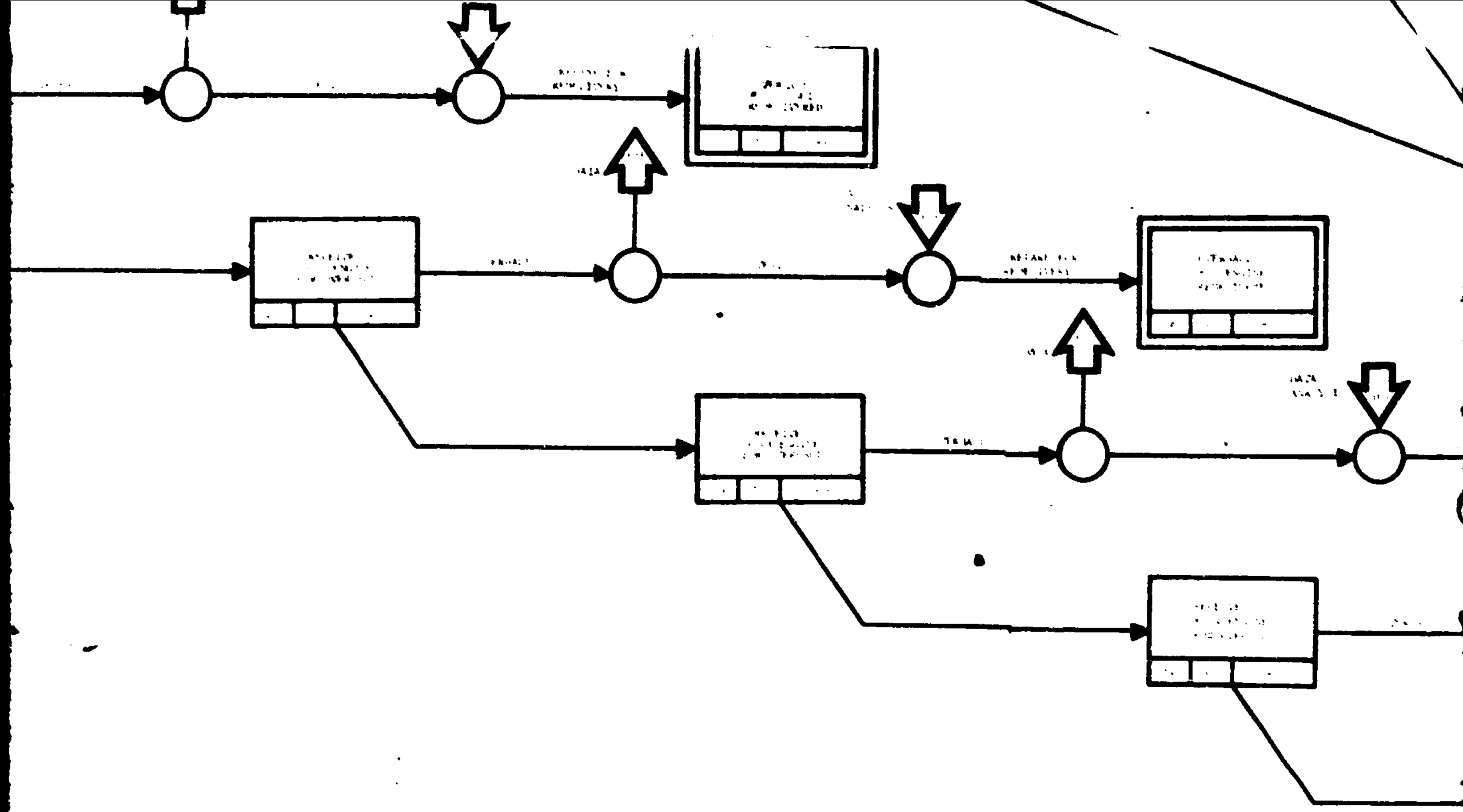
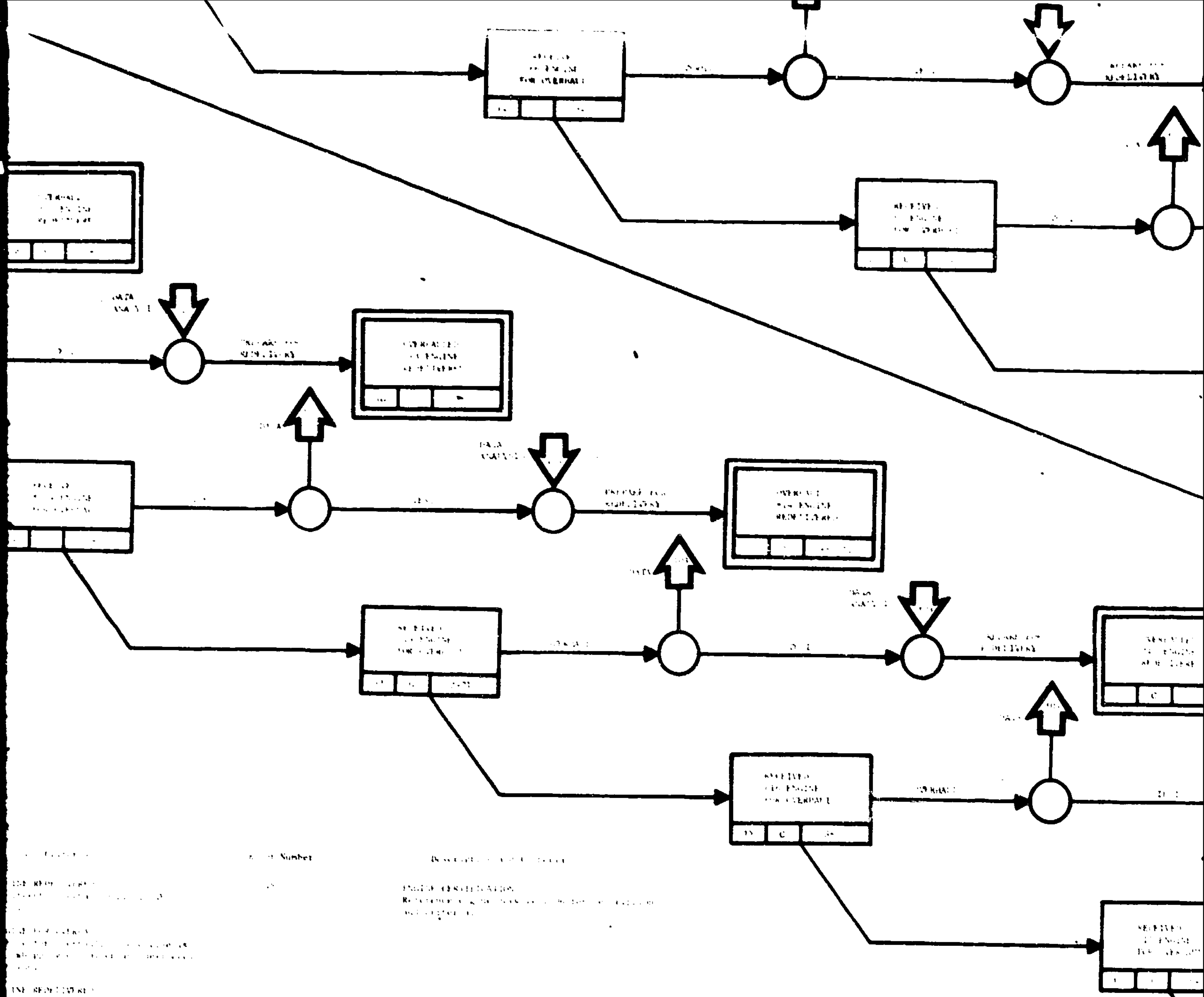
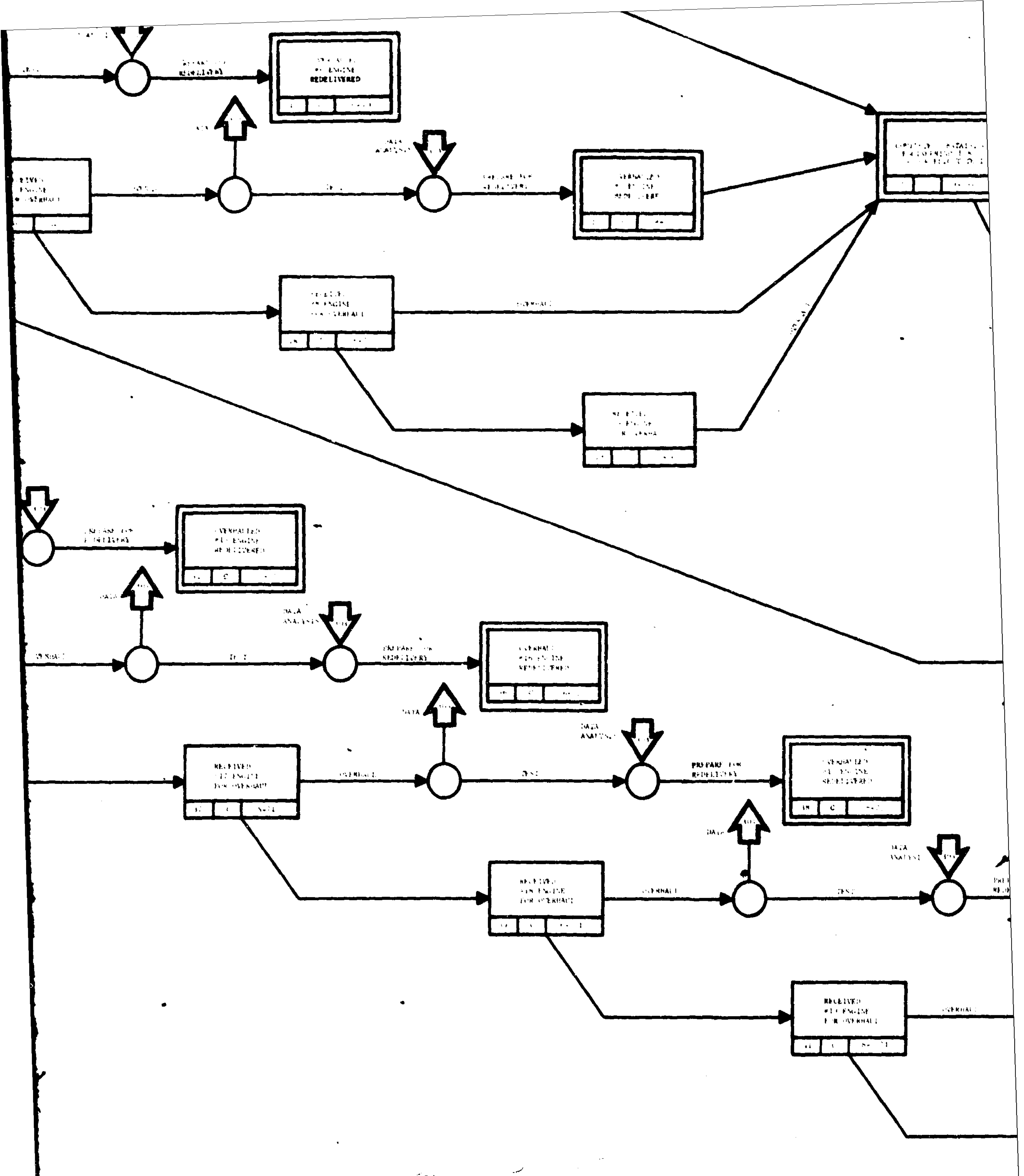
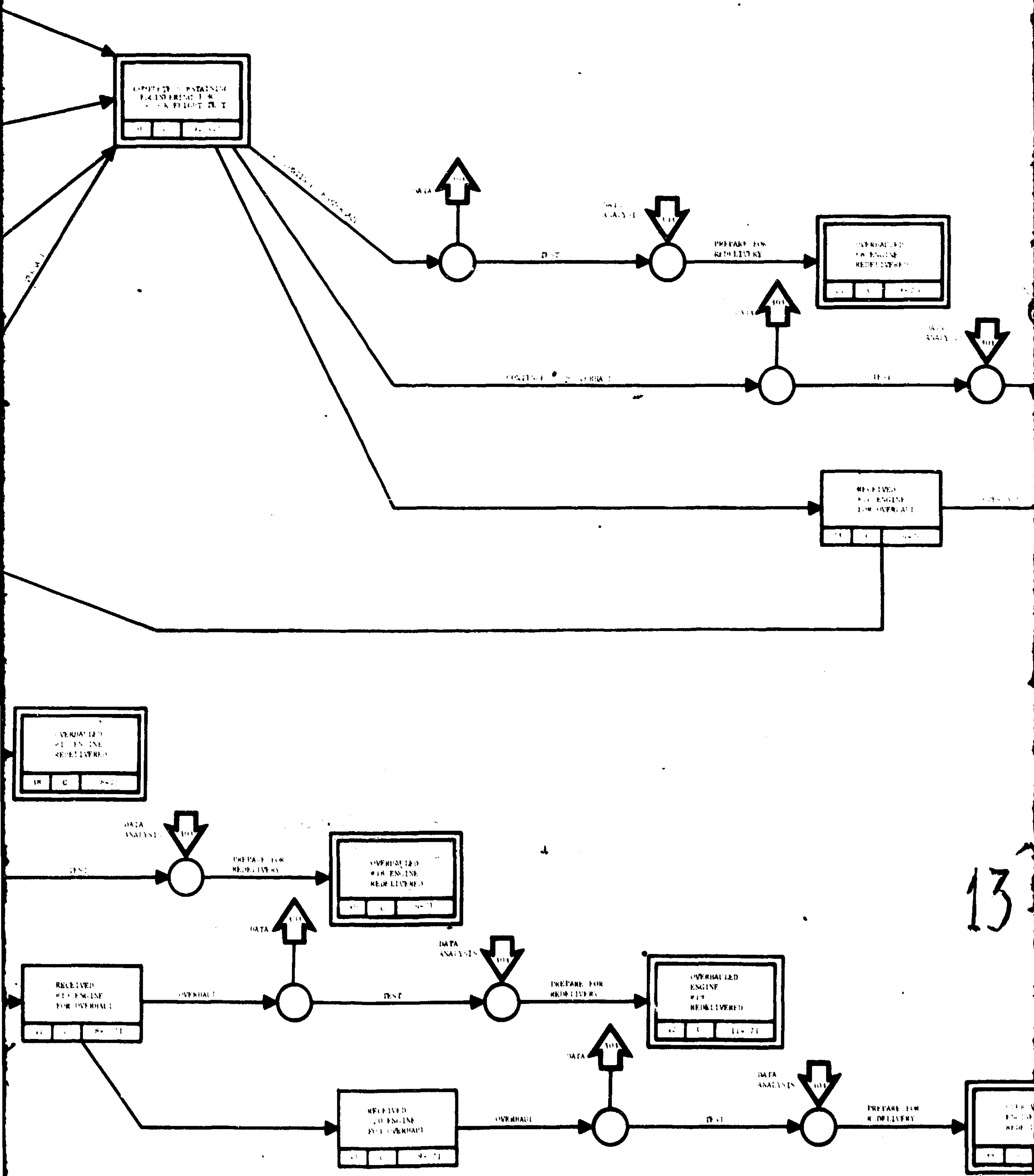


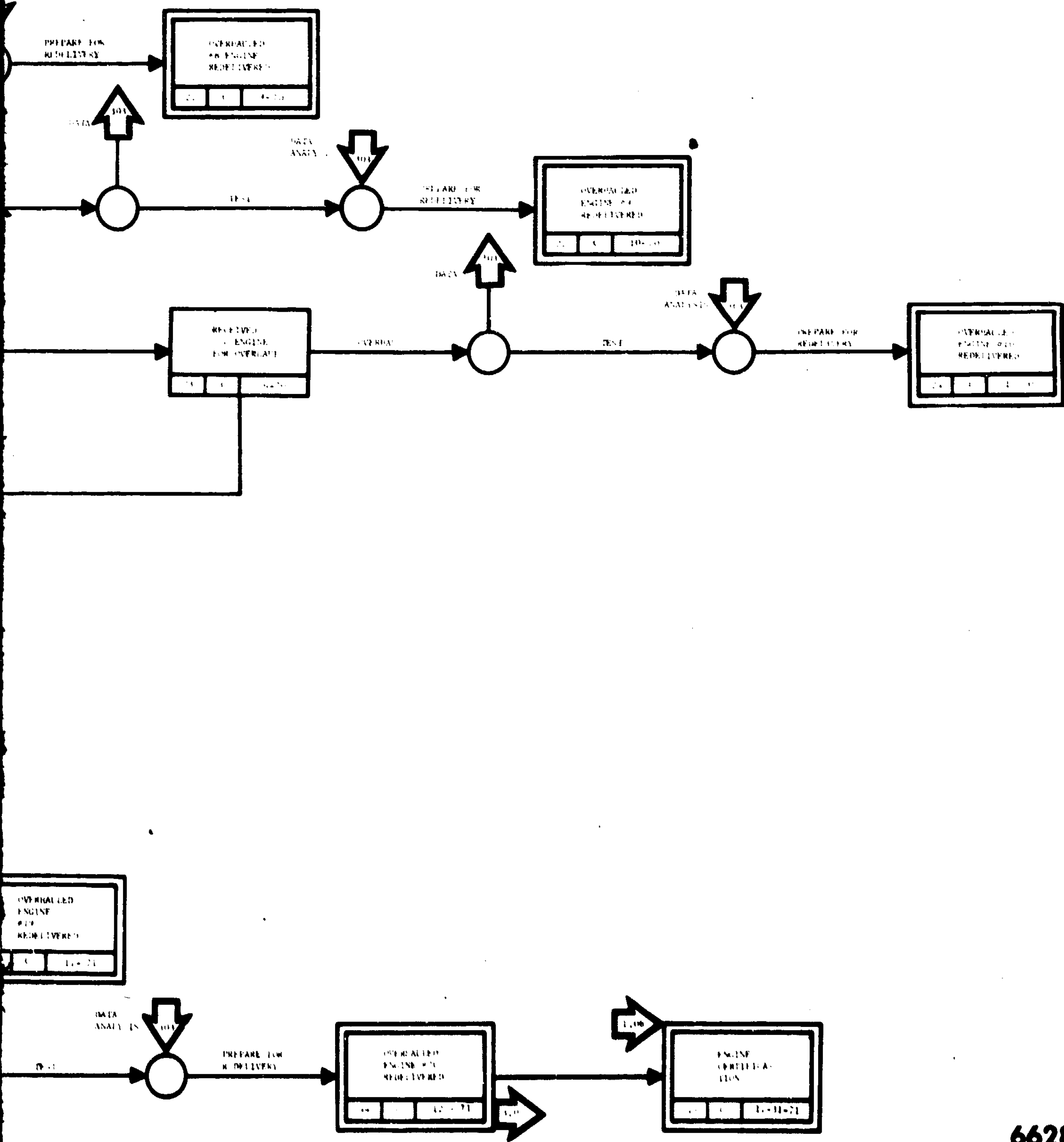


11


RECEIVED
OVERHAUL
PREPARE FOR REDELIVERY
REDELIVERED
DATA


DATA
TEST
PREPARE FOR REDELIVERY
DATA ANALYSIS
OVERHAUL
OVERHAULED ENGINE
REDELIVERED
RECEIVED
FOR OVERHAUL

13



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3.07 ENGINE TEST AND EVALUATION-FLIGHT

The operational suitability of the JTF17 engine-airframe combination functioning as a system will be determined, in a large part, by the 100-hour Flight Test Program in Phase III. Pratt & Whitney Aircraft will work with the airframe manufacturer to conduct a flight test program directed at successful demonstration of the capability of the SST to accomplish the basic domestic and international missions.

The prime objective of the flight test program is to demonstrate the operational suitability of the SST engine-airframe combination. The following Phase III program objectives are directed toward this goal.

1. Prepare, implement and maintain a flight test program in conjunction with the airframe contractor.
2. Demonstrate suitability of the prototype JTF17 engine for flight test by successful completion of the FTS.
3. Deliver the twenty ground, taxi, and prototype JTF17 engines.
4. Provide adequate engineering and product support coverage at all test sites during all phases of the flight test program.

In order to meet these objectives the following programs will be accomplished:

A program in support of the flight test program will be conducted including distortion testing of the fan and high compressor individual rigs, full-scale engine distortion testing with a distortion generator and a simulated airframe inlet, engine-inlet compatibility testing at AEDC in conjunction with the airframe contractor, airframe component - engine compatibility testing, and the delivery of the twenty ground, taxi, and flight test engines. The ground, taxi, and flight test engines will be instrumented and calibrated since they provide the data for verification of the engine-airframe compatibility and suitability.

The ground test program is a coordinated effort with the airframe contractor and will include uninstalled ground tests and installed ground tests to determine noise characteristics, starting characteristics, forward and reverse thrust response, performance, vibratory characteristics, inlet distortion, foreign object ingestion susceptability, and maintenance demonstrations.

The flight test program is a coordinated effort with the airframe contractor and will include performance, windmill test, vibratory characteristics, inlet distortion, main and duct heater relights and fuel control system tests at steady state and transient conditions.

Pratt & Whitney Aircraft will provide qualified engineering field service and technical personnel at all field activities in ample time to ensure coordination with the airframe contractor and completion of plans and facilities prior to ground and flight test operations. Pratt & Whitney Aircraft will provide field service representatives, field engineers, spare parts representatives, technicians, ground support equipment and spare parts required for maintenance and operation of the JTF17 engine throughout the flight test program.

The major milestones, network chart and event dictionary for the engine flight test program are shown in figures 11 and 12, respectively.

A detailed description of the flight test program is presented in the Test and Certification Plan, Volume III, Report E, and test planning and integration is presented in Test, Volume IV, Report E.

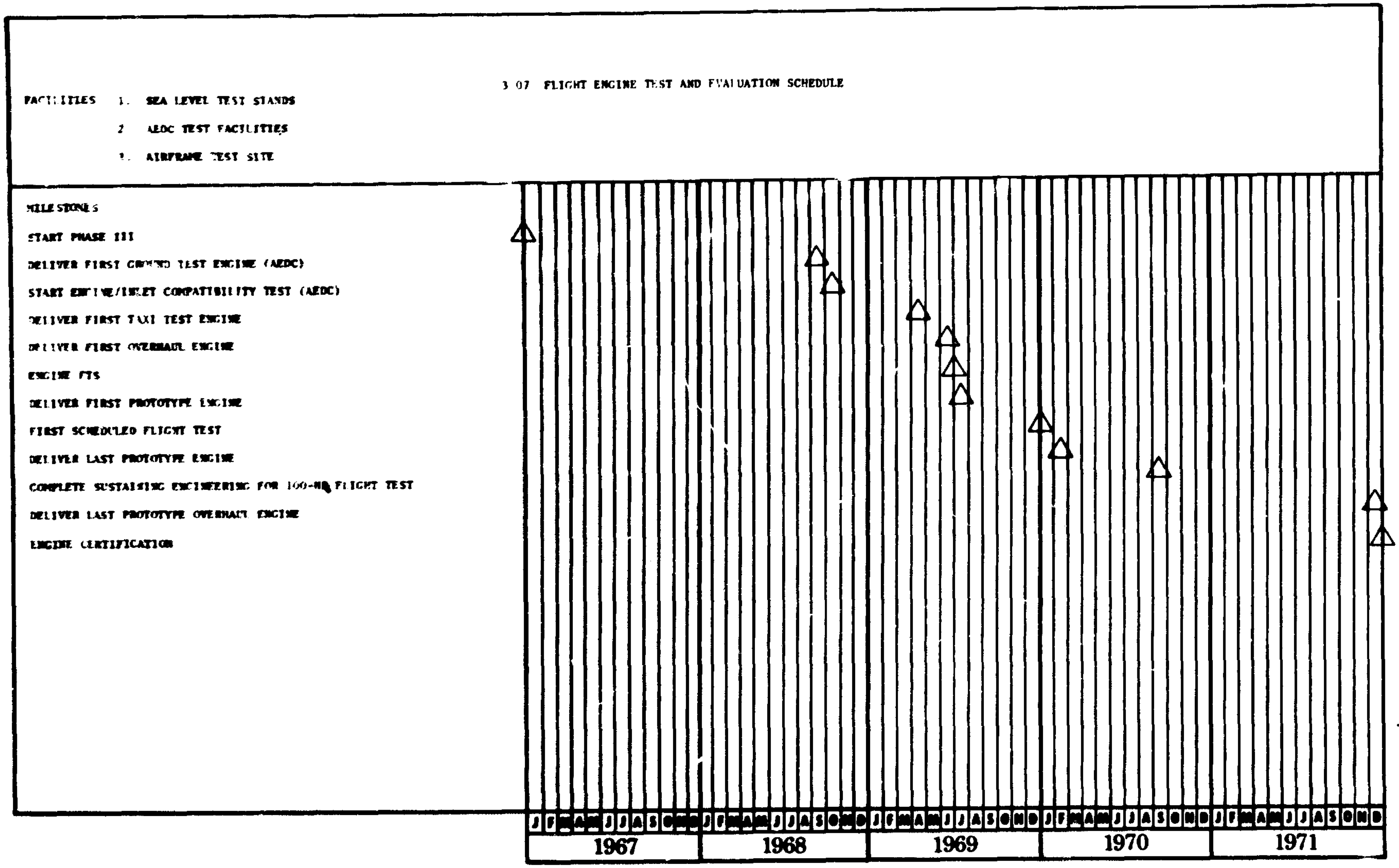

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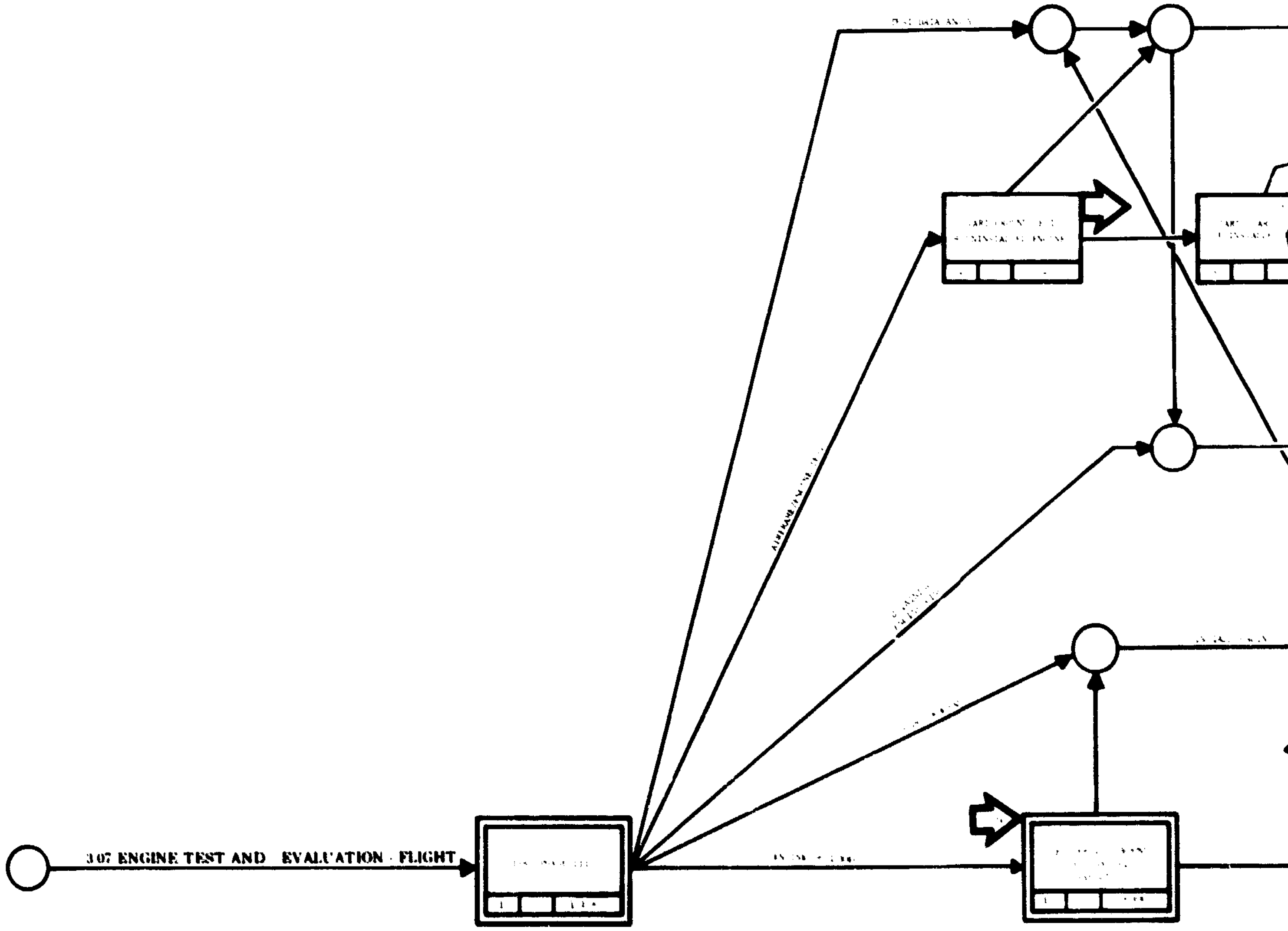
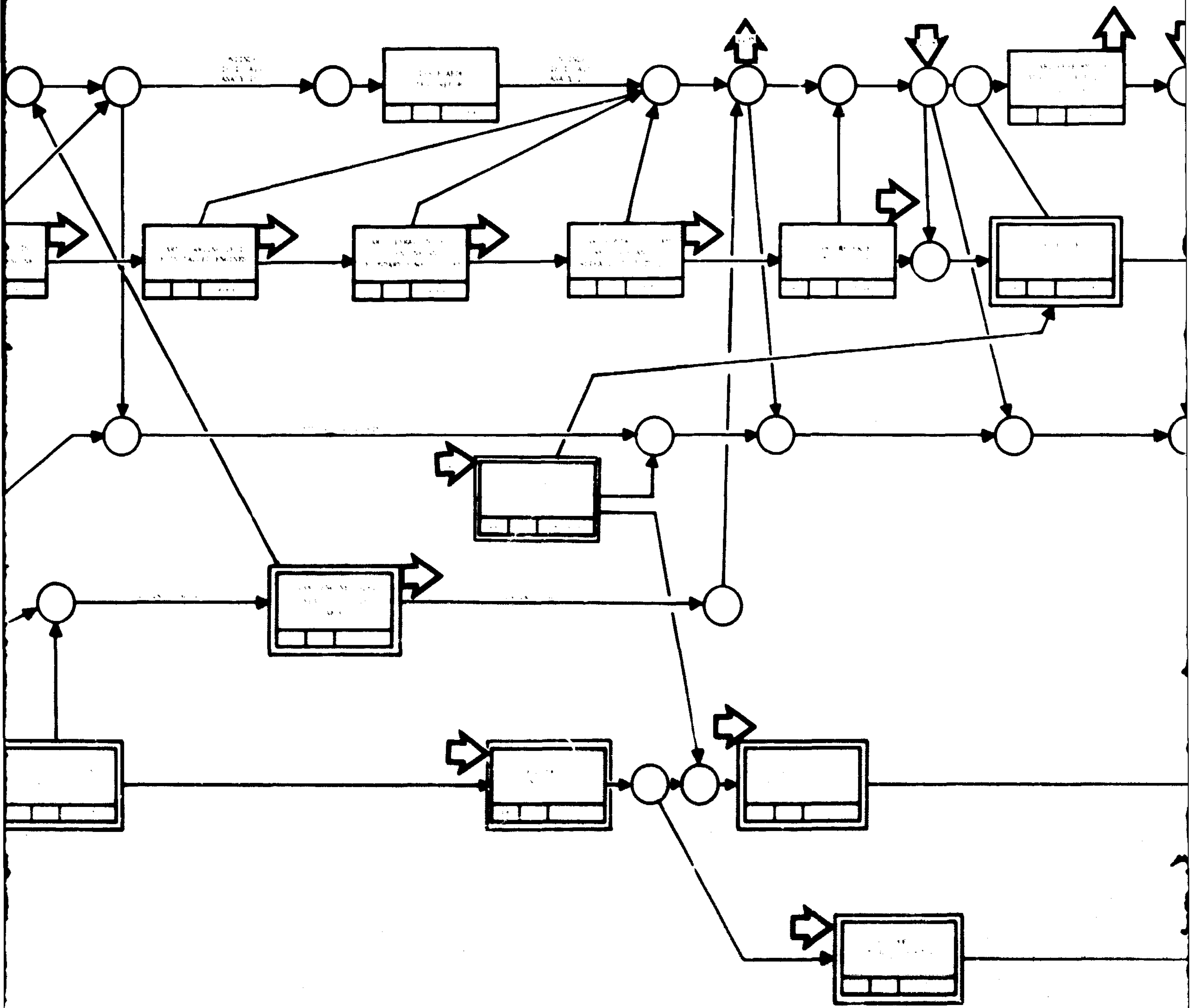
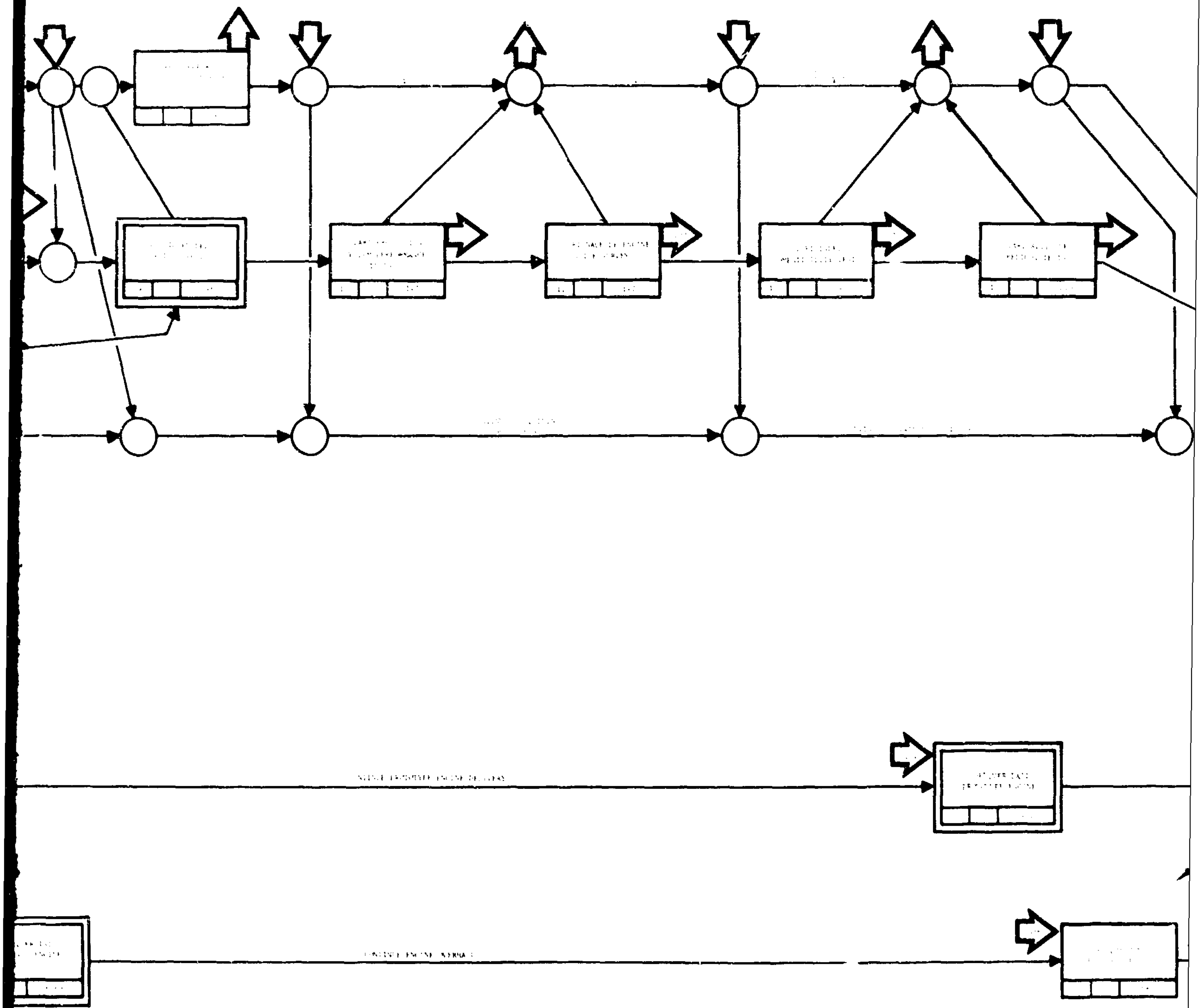
Figure 11. 3.07 Engine Test and Evaluation - Flight


3.07 ENGINE TEST AND EVALUATION - FLIGHT



...gine Test and Ev''ation-Flight



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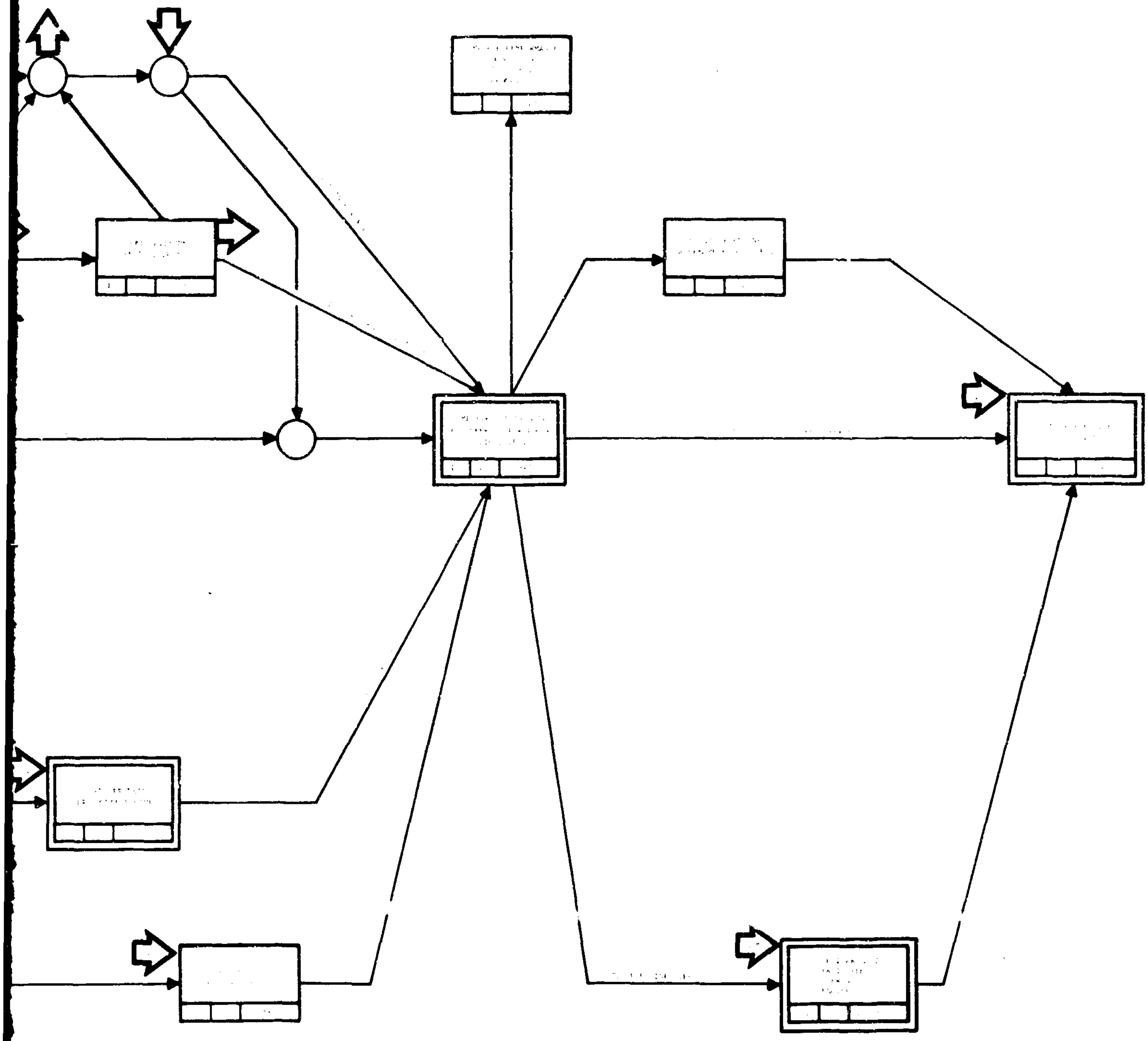

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3.08 DATA AND HANDBOOKS

All publications required for the operation, maintenance, overhaul and logistics support of the JTF17 engine will be published and distributed by the Service Publications Group as described in detail in Product Support, Volume IV, Report F, Section VI. Revisions to reflect changes in procedures or configuration will be issued as necessary throughout the service life of the engine.

Engine operation and maintenance data requirements by the airframe manufacturer for inclusion in the aircraft maintenance and flight operations manuals will be provided by Pratt & Whitney Aircraft in scope and scheduled to assist the airframe manufacturer in meeting the program requirements. Pratt & Whitney Aircraft will also review and provide technical comments on engine data prepared for distribution in the airframe manufacturer's manuals

The following criteria are used in the preparation and publication of data and handbooks for the JTF17 engine:

1. Format - Engine Maintenance and Overhaul Manuals, Illustrated Parts Catalogs, and Service Bulletins will be in strict compliance with ATA Specification No. 100.

   Installation Handbooks, Operating Instructions, Special Tool Manuals and Facility Planning Manuals, which are not required by ATA Specification No. 100, will be presented in a standard P&WA format that has been used successfully in past and current commercial airline engine programs.

2. Accuracy - The JTF17 publications will be prepared by a team of experienced technical writers. Each publication will be reviewed by Product Support technical specialists and by appropriate Project Engineering personnel. All basic publications and revisions will be validated prior to issuance.

3. Comprehension and Completeness - All data and handbooks will be written in a clear, precise manner with short, direct sentences and paragraphs. The scope and purpose of each publication will be stated in the introduction; detailed indexes as well as tables of contents will be included. Illustrations, charts, graphs, and tables will be employed to minimize the need for complex textual explanations, and abbreviations or complex technical terms will be fully explained. Cautions and warnings will be included in accordance with ATA Specification No. 100 requirements to eliminate the possibility of hazard to personnel or equipment.

   The basic publications will contain all available data required for support of the JTF17 engine.

4. Schedules - Pratt & Whitney Aircraft will provide the following publications to support the JTF17 engine and scheduled to be consistent with engine deliveries and other milestones to ensure timely availability:

Installation Handbook	Available 1966
Operating Instructions	July 1968
Service/Overhaul Manual	September 1968
Engine Maintenance Manual	April 1969
Illustrated Parts Catalog	July 1969
Service Bulletins	As required
General - Airframe Data	As required
Facility Planning Manual	Phase IV
Engine Overhaul Manual	Phase IV
Accessory Component Overhaul Manual	Phase IV
Engine Special Tool Manual	Phase IV

All publications will be updated every 90 days, or more frequently if required, to reflect changes in engine configuration, operation, test, maintenance, etc.

3.09 TRAINING AND TRAINING EQUIPMENT

TRAINING

The Pratt & Whitney Aircraft Service School has been conducting customer training courses with a professional instructor staff since its founding in 1935. Turbojet engine training for approximately 18,000 engineers and technicians has been provided by the staff now numbering 25. A portion of this training has covered supersonic engines, including extensive courses on the J58 engine.

The necessity for proper and timely training of customer personnel to ensure the level of knowledge and capability necessary for engine operation, maintenance and logistic support is fully recognized, and courses covering all support phases of the JTF17 engine will be presented. This training plan is described in detail in Product Support, Volume IV, Report F, Section VI.

The various types and content of training programs and starting dates are based upon our past experience, knowledge and evaluation of the JTF17 and the schedules for SST ground, flight test and airline operation.

All courses will be updated as required to reflect changes in engine configuration and operation and will be repeated as necessary to satisfy customer requirements throughout the service life of the engine.

The courses and starting dates of instruction to be presented to the FAA, airlines, and airframe personnel are as follows:

Staff Orientation	May 1967
Operation and Performance	July 1967
Operation and Test	June 1968
Organizational Maintenance	July 1968
Expanded Operation and Performance	Phase IV
Heavy Maintenance	Phase IV
Overhaul	Phase IV
Engine Flight Simulator Training	To be coordinated

Instructors experienced in the preparation and presentation of training courses for airline operators will be selected for the JTF17 program.

The instructor staff will be assisted in the technical preparation by personnel from the Design, Project Engineering, and Product Support organizations to ensure accuracy and completeness of all phases of JTF17 support training.

TRAINING EQUIPMENT

The Pratt & Whitney Aircraft Service School will employ modern training equipment and training aids for the JTF17 engine program, described in detail in Product Support, Volume IV, Report F, Section VI, as dictated by the requirements of the different courses.

The following is a brief description of the equipment which will be used:

Training Texts
Schematic Diagrams
VuGraph Transparencies
Movies and/or Video Tapes
Engine Parts and Cutaways
Operable JTF17 Engine
Engine Test Stand
Engine Tools and Fixtures
Miscellaneous Student Equipment

3.10 GROUND SUPPORT EQUIPMENT

Specialized equipment required for the maintenance, overhaul and test of the JTF17 engine will be designed, verified and released for manufacture by the Service Tools and Equipment Group, described in detail in Product Support, Volume IV, Report F, Section VI.

Experienced personnel from the Tools and Equipment Group, Design, Project, Maintainability and Service Engineering have conducted an extensive study of the JTF17 engine and of current airline practices in establishing the GSE concept which will be utilized in SST operation.

The modular design and other maintainability features of the JTF17 engine described in the Maintainability Program, Volume IV, Report F, Section I, will permit extensive maintenance of the engine while installed in the airplane. Close engine/airframe coordination will be maintained with the manufacturer to ensure that adequate engine tooling will be designed for all possible installed maintenance and inspection tasks.

GSE and facilities utilized for other P&WA engine models will be reviewed in order to avoid duplication and, where possible, modified to permit common usage.

GSE designers and process planners, in conjunction with representatives of Engine Design, Service Engineering, Maintainability, Human Engineering, and other appropriate elements will design all special engine equipment required for field support of the JTF17 engine.

Tooling provided for the ground and flight test programs will be of the same quality and design standards as employed for airline operation. Prior to release for service use, each new or modified tool will be validated by use on an engine. Personnel from the Tools and Equipment and other affected groups will witness the maintenance tasks which will be performed by technicians with normal skill levels.

Upon completion of validation, the P&WA equipment is placed under an Engineering Change system in the same manner as engine parts Each Engineering Change in process against the engine is reviewed by the Tools and Equipment Group to determine whether tooling is affected. If existing equipment [illegible] or modified, redesign is initiated and released by a Service Tool Engineering Change.

Applicable ground support equipment will be delivered to the required locations three months prior to receipt of the first engine at each location.

SECTION IV
CROSS-REFERENCE INDEX

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1.02	VH-9	Fabrication and Assembly	2.01 2.02
1.03	VH-15	Tooling	2.01
1.04	VH-19	Engine Instrumentation	2.03
1.05	VH-23	Test Equipment	2.04
1.06	VH-27	Engine Test - Ground	2.05
1.07	VH-37	Engine Performance	3.01
1.08	VH-41	Inlet System Compatibility	1.10
1.09	VH-45	Noise	1.11
1.10	VH-49	Growth Potential	3.03
1.11	VH-53	Fan and Compressor	1.01
1.12	VH-57	Primary Combustor	1.02
1.13	VH-61	Turbine	1.03
1.14	VH-65	Augmentor	1.04
1.15	VH-69	Exhaust System	1.05
1.16	VH-73	Controls and Accessories	1.06
1.17	VH-79	Lubricants, Lubrication System, Bearings, Seals and Gears	1.07 1.09
1.18	VH-85	Fuels	1.08
1.19	VH-89	Manufacturing Techniques and Materials	3.04
1.20	VH-93	Weight Control and Status	3.05
2.01	VH-97	Coordination	1.13
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CROSS-REFERENCE INDEX (Continued)

DETAIL WORK PLAN Section	Page	WORK STATEMENT ITEM	PHASE III RFP Section
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2.05	VH-111	Value Engineering	4.04
2.06	VH-115	Configuration Management	4.05
2.07	VH-119	Safety	4.06
2.08	VH-123	Test Planning and Integration	4.08
2.09	VH-127	Data Management	6.01
2.10	VH-131	Program Management and Controls	6.02
2.11	VH-133	Facilities Plan	6.03
2.12	VH-137	Cost Analyses	6.04
2.13	VH-139	Proposals	6.0
3.01	VH-141	Ground, Taxi and Flight Test Engines	2.06 2.08
3.02	VH-145	Tooling	2.01
3.03	VH-149	Engine Performance	3.01
3.04	VH-153	Engine Mockup	1.12
3.05	VH-157	Spares	5.03
3.06	VH-159	Overhaul	5.0
3.07	VH-163	Engine Test and Evaluation - Flight	2.06 2.07 2.08
3.08	VH-167	Data and Handbooks	5.01
3.09	VH-169	Training and Training Equipment	5.02
3.10	VH-171	Ground Support Equipment	5.04